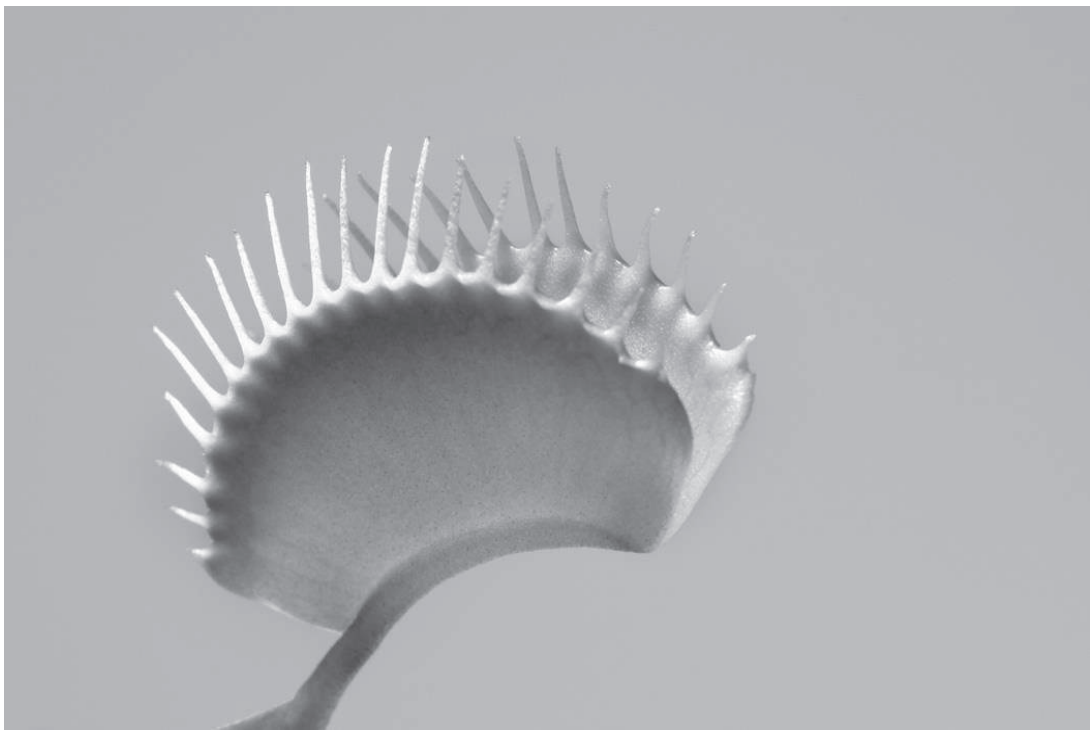


A LEVEL Biology

15. Control and Coordination

Paper 4 (2013-2025)



Classified by Mr. Adeel Ahmad

9700/41/M/J/13

- 6 (a) Fig. 6.1 outlines how a cholinergic synapse works.

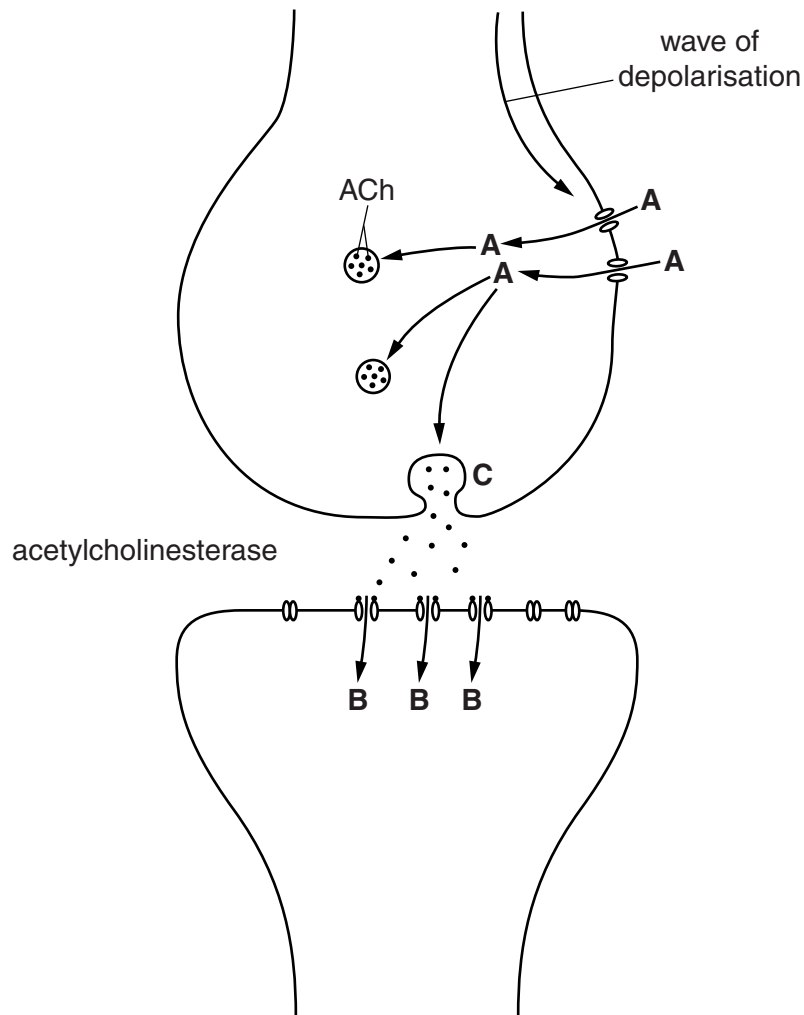


Fig. 6.1

With reference to Fig. 6.1:

- (i) name **A** and **B**

A

B [2]

- (ii) name the process occurring at **C**

..... [1]

- (iii) state the effect of **B** entering the post-synaptic neurone

..... [1]

- (iv) explain the role of acetylcholinesterase in the synapse.

.....

.....

.....

.....

.....

..... [3]

- (b) Some synapses in the brain use the neurotransmitter dopamine. After the postsynaptic membrane has been depolarised, dopamine leaves the receptor proteins and moves back into the presynaptic neurone through specific transporter proteins.

Schizophrenia is a condition in which there is a higher than usual concentration of dopamine in certain areas of the brain. The drug phenothiazine has a similar shape to dopamine and is used to treat schizophrenia.

Suggest and explain what occurs at the synapse when phenothiazine is used in the treatment of schizophrenia.

.....

.....

.....

..... [2]

9700/42/M/J/13

4. (b) The brain depends on a constant supply of oxygen for aerobic respiration. Anaerobic respiration is not sufficient to keep neurones in the brain alive. This is because neurones require especially large amounts of ATP. Up to 80% of the ATP is used to provide energy for the Na^+/K^+ pump.

When a person suffers a stroke, blood flow to part of the brain is stopped, so some neurones receive no oxygen. ATP production by oxidative phosphorylation stops. Fig. 4.1 shows some of the ways in which the lack of ATP affects a neurone in the brain.

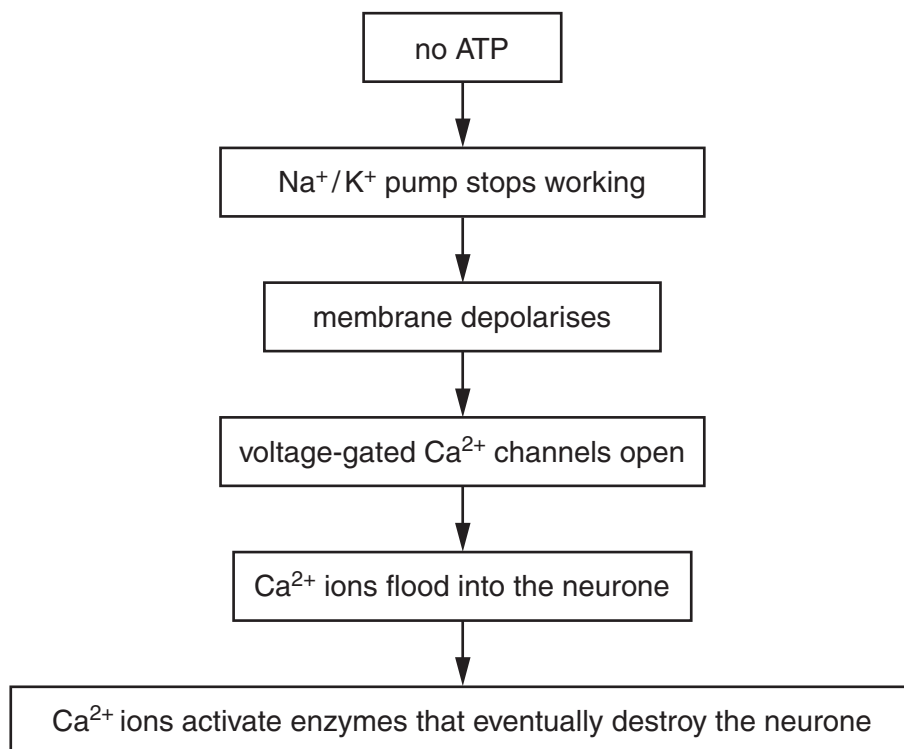


Fig. 4.1

- (i) Explain why the membrane of the neurone depolarises when the Na^+/K^+ pump stops working.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (ii) Suggest why calcium ions flood into the neurone when the Na^+/K^+ pump stops working.

.....

.....

.....

..... [2]

- (c) The freshwater turtle, *Trachemys scripta*, is able to survive for long periods in conditions of very low oxygen concentration. As in humans, the rate of activity of the Na^+/K^+ pump in the neurones in its brain falls sharply. However, in turtles this does not result in damage to these cells.

A better understanding of how the neurones in the turtle's brain survive in these conditions could lead to new treatments for people who have suffered a stroke.

Experiments show that, in turtle brain neurones, in conditions of low oxygen availability:

- most ion channels in the cell surface membranes immediately close
 - after about four hours, the quantity of mRNA involved in the synthesis of proteins used to build ion channels, falls to less than one fifth of normal concentrations.
- (i) Suggest how the closure of ion channels in the neurones of the turtle in very low oxygen concentrations could allow the cells to survive.

.....

 [2]

- (ii) Suggest what causes the quantity of mRNA for protein channels to fall.

.....

 [2]

[Total: 16]

- 4 (a) Blood samples were taken from a 29 year old woman each day for a period of 43 days. The concentrations of oestrogen, progesterone and luteinising hormone (LH) in each sample were measured. The results are shown in Fig. 4.1.

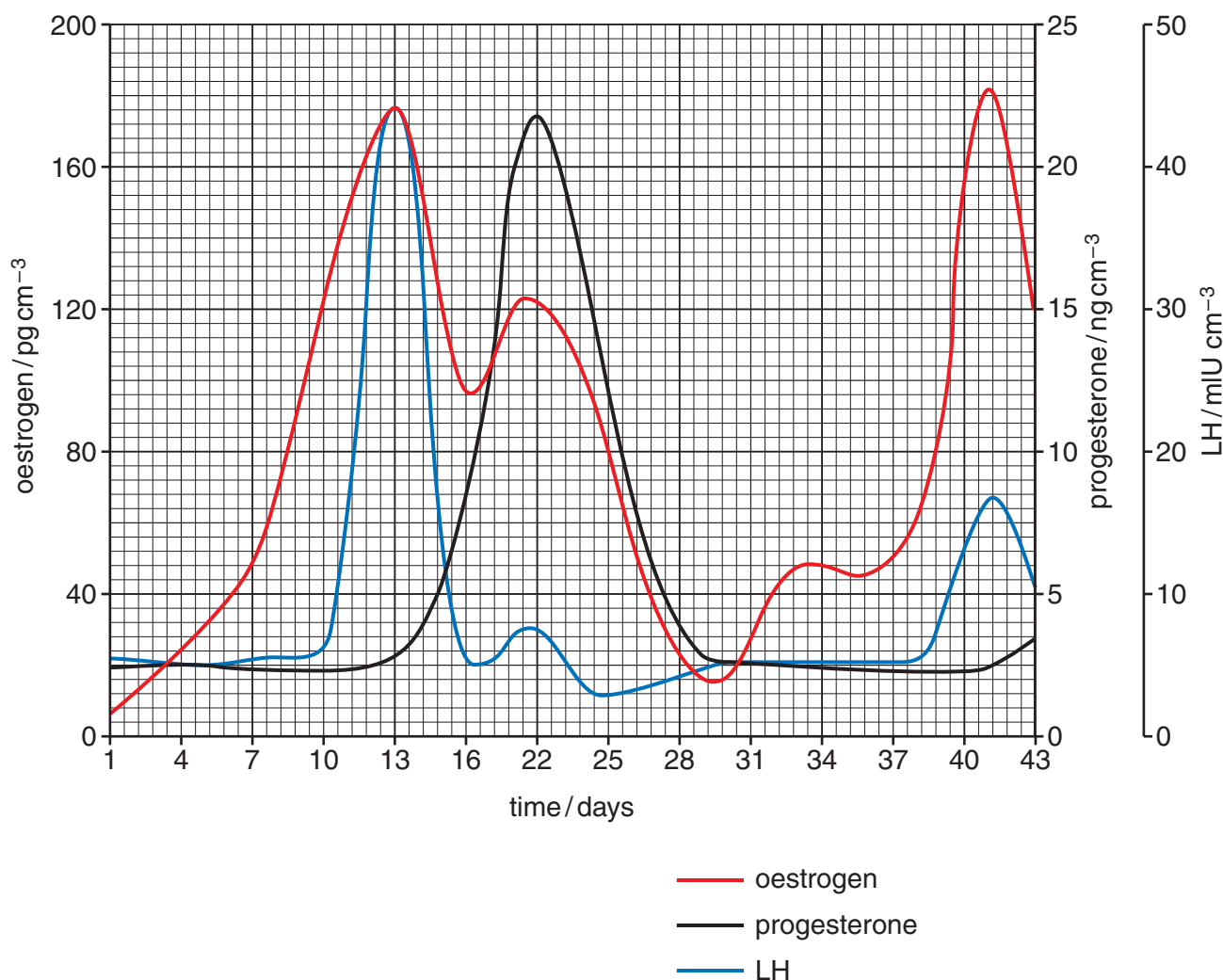


Fig. 4.1

- (i) Estimate the length of the woman's menstrual cycle. Show how you worked out your answer.

answer (days) [2]

- (ii) The luteal phase is the part of the cycle when a corpus luteum is present in the ovaries. It begins immediately after ovulation, and ends when menstruation starts.

Use Fig. 4.1 to suggest when the luteal phase began and ended.

began ended [2]

(iii) Name the organ that secretes LH.

.....[1]

(iv) Describe the roles of LH in the menstrual cycle.

.....

[3]

(b) An investigation was carried out to determine whether the ability of a woman to perform a task involving spatial ability varied at different times of her menstrual cycle.

The investigation involved 12 women. They each performed 24 similar spatial tasks on day 2 and day 22 of their menstrual cycle, for six successive cycles. The tasks involved mentally rotating 3-D shapes.

The researchers used two methods to determine the phase of the menstrual cycle.

- Each woman was asked when her previous menstrual period had begun.
- After each test, a blood sample was taken and the concentrations of oestrogen, progesterone and LH were measured.

(i) Suggest why the researchers used two methods to determine the phase of the menstrual cycle.

.....

[2]

- (ii) The mean score for women taking the tests on day 2 of their cycle was 10.50 out of 24. The mean score for women taking the tests on day 22 of their cycle was 7.38 out of 24.

Discuss whether or not these results support the hypothesis that the concentration of oestrogen in the blood affects the ability to perform spatial tasks.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 14]

- 6 (a) Table 6.1 shows the mean axon diameter and mean speed of conduction of nerve impulses for four different animals.

Table 6.1

animal	type of neurone	axon diameter / μm	mean speed of conduction / ms^{-1}
A – mammal	myelinated	4	25
B – mammal	unmyelinated	5	3
C – amphibian	myelinated	14	35
D – amphibian	myelinated	10	30

With reference to Table 6.1, describe:

- (i) the effect of myelination on the speed of conduction of impulses in mammals

.....

 [2]

- (ii) the effect of axon diameter on the speed of conduction of impulses in amphibians.

.....

 [2]

- (b) Explain how myelination affects the speed of conduction of impulses.

.....

 [3]

- (c) Multiple sclerosis (MS) is an auto-immune condition of humans in which the body's immune system attacks the myelin sheaths which are then damaged. This leads to a decrease in information reaching the brain from sensory receptors.

- (i) Suggest how the myelin sheaths may be attacked.

.....

.....

.....

.....[2]

- (ii) Explain why this damage leads to a decrease in information reaching the brain from sensory receptors.

.....

.....

.....

.....[2]

[Total: 11]

- 9 The passage below summarises the effects of gibberellins on seed germination.

Complete the passage by using the most appropriate scientific term(s).

When a seed is shed from the parent plant, it is in a state of ,
which means it is metabolically inactive.

When water is absorbed by a seed, it stimulates the production of gibberellin by the
..... within the seed. The gibberellin stimulates the synthesis of
amylase by cells in the layer.

Amylase hydrolyses starch molecules in the converting them
to soluble molecules. These molecules are converted to
glucose which is transported to the embryo, providing a source of carbohydrate that can be
respired to provide as the embryo begins to grow.

Gibberellin causes these effects by regulating genes that are involved in the synthesis of
amylase. It has been shown that application of gibberellin to seeds can cause an increase in
the of the DNA coding for amylase.

[Total: 7]

- 4 Many women use knowledge of their menstrual cycle as a family planning method, avoiding sexual intercourse during the part of the cycle when it is possible for fertilisation to occur. This part of the cycle is known as the fertile window.

In women with regular, 28-day menstrual cycles, ovulation is likely to take place on day 14. Most guidelines state that the fertile window lasts from day 10 to day 17 of the menstrual cycle.

- (a) Explain why the fertile window begins several days before ovulation takes place.

.....

 [2]

- (b) Fig. 4.1 shows how basal body temperature, and the concentration of luteinising hormone, LH, varied during one menstrual cycle of a woman. Basal body temperature is the temperature of the body just after waking in the morning.

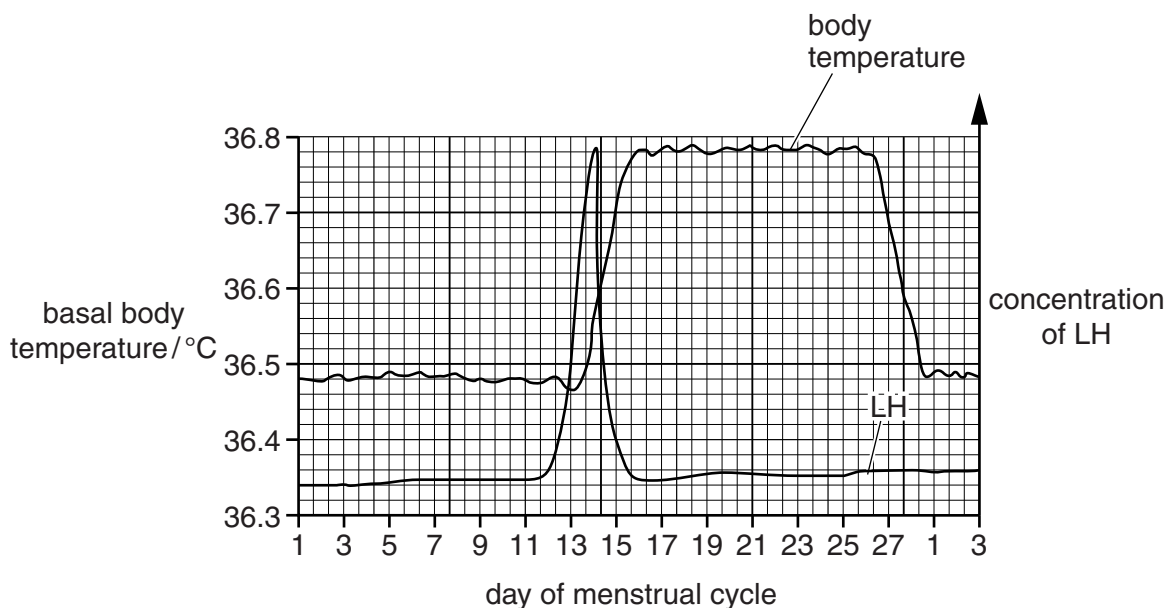


Fig. 4.1

- (i) On Fig. 4.1, sketch a curve to show the changes in the concentration of progesterone in the blood during this menstrual cycle. [2]
- (ii) The follicular phase of the menstrual cycle begins when menstruation starts, and ends when ovulation takes place.

With reference to Fig. 4.1, suggest when the follicular phase began and ended during this menstrual cycle.

began ended [1]

(c) Three methods that a woman can use for determining her fertile window are:

method 1 using the date at which each menstruation begins to predict when ovulation will occur

method 2 using disposable urine dip sticks to measure the amount of LH breakdown products in urine (the more LH in the blood, the more breakdown products are present in urine)

method 3 wearing an electronic device in the armpit that continuously measures body temperature.

(i) Suggest why using **method 1** alone is not likely to be a very reliable method of avoiding conception.

.....

.....

.....

..... [2]

(ii) Explain how **method 2** could be used to avoid conception.

.....

.....

.....

..... [2]

(iii) Suggest why **method 3** is likely to be a better predictor of ovulation than measuring basal temperature with a thermometer each day.

.....

.....

.....

..... [2]

- (d) A study was carried out into the timing of the fertile window. The study involved 221 women who were trying to get pregnant.

Urine samples from each woman were tested for LH breakdown products every day for several months. The women recorded the days on which they had sexual intercourse, and also the days on which menstruation began.

136 of the women became pregnant during the study.

The results were used to calculate the probability of a woman being in the fertile window on each day of her cycle. The results for women with regular 28-day cycles are shown in Fig. 4.2.

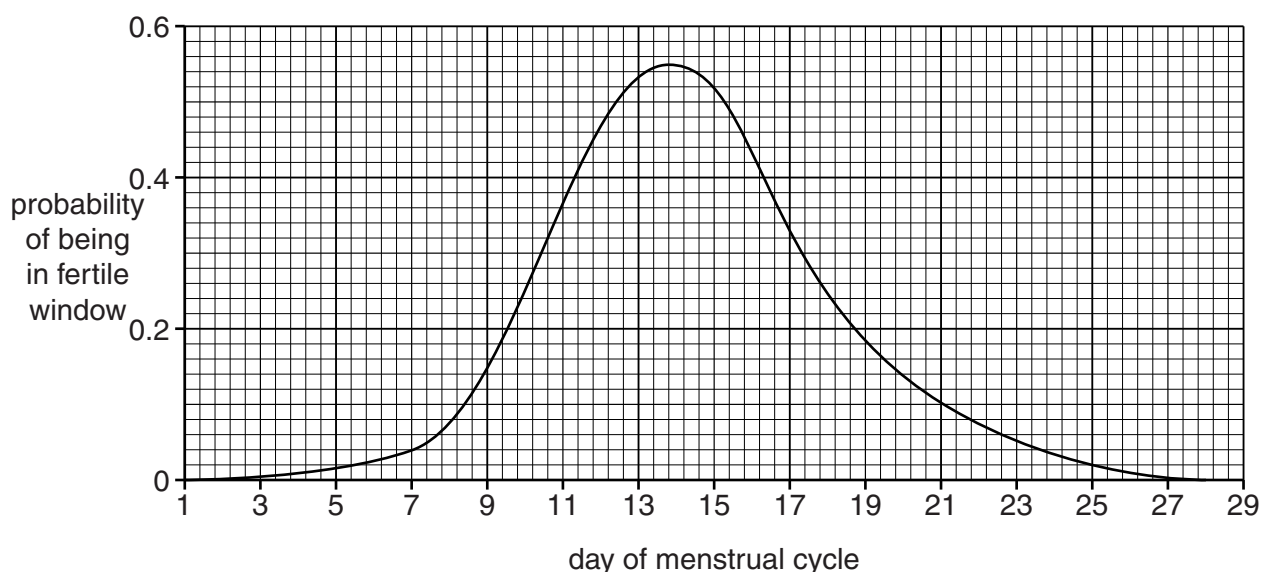


Fig. 4.2

Discuss what these results suggest about the guidelines that the fertile window lasts from day 10 to day 17 of the menstrual cycle.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 15]

- 6 Fig. 6.1 is a trace that shows the changes that occur in the membrane potential of a neurone during an action potential.

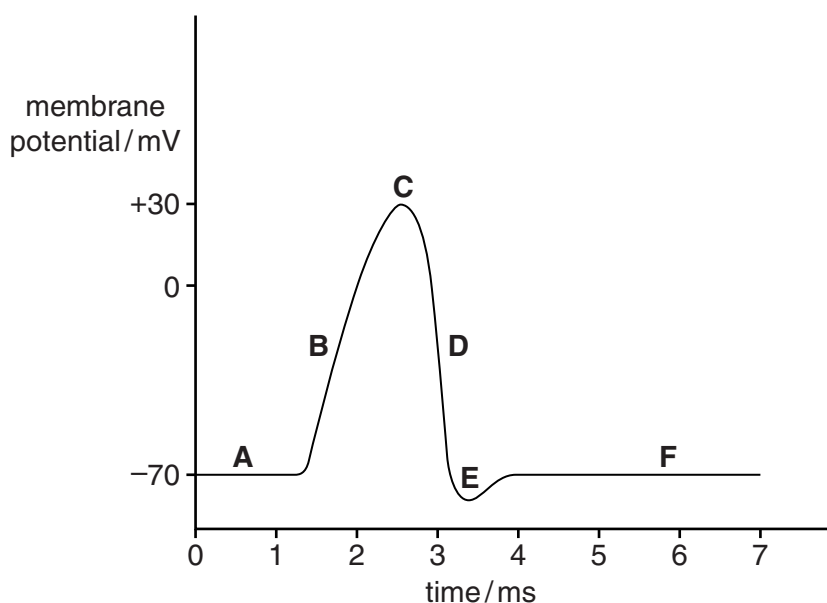


Fig. 6.1

- (a) Using the letter(s) **A** to **F** from Fig. 6.1, state which letter(s) corresponds to the following:

(i) depolarisation

(ii) hyperpolarisation

(iii) the membrane is most permeable to potassium ions

(iv) resting potential [4]

- (b) Saxitoxin is a powerful poison produced naturally by single-celled, eukaryotic, photosynthetic, marine organisms. Shellfish may consume organisms containing saxitoxin but are unaffected. If humans were to eat shellfish containing saxitoxin they would become very ill and may die.

- (ii) Saxitoxin blocks sodium ion channels in the cell surface membranes of neurones.
Describe the role of sodium ion channels in the transmission of a nerve impulse.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (iii) Suggest why saxitoxin may be fatal to humans.

.....

.....

.....

..... [2]

[Total: 10]

- 9 The passage below summarises the effects of auxin on the growth of a shoot.

Complete the passage by using the most appropriate scientific term(s).

Auxin is synthesised in the growing tips of shoots (apical buds). It is transported from here down the shoot by from cell to cell and also to a lesser extent by flow in the

Auxin seems to be involved in determining whether a plant grows upwards or whether it branches sideways. When the apical bud is actively growing, it tends to stop lateral buds from growing. This is called apical The plant grows upwards rather than branching out sideways.

However, if the apical bud is cut off, the lateral buds start to grow. It is thought that removal of the apical bud causes the concentration of auxin in lateral buds to so the buds can now grow by cell and cell

[Total: 7]

- 6 (a)** The passage below outlines how sensory receptors work.

Complete the passage by using the most appropriate scientific term(s).

A sensory receptor cell responds to a stimulus by opening ion in its cell surface membrane. Sodium ions flood into the cell causing the membrane to become This is called the potential. If this potential is large enough to reach a then an action potential is transmitted to the central nervous system. An increase in the strength of the stimulus will result in an increase in the of action potentials transmitted. [5]

- (b)** Describe how an action potential is **transmitted** along a sensory neurone in a mammal.

[5]

[Total: 10]

- 5 The hormone FSH (follicle stimulating hormone) plays important roles in the reproductive cycles of mammals.

(a) State the precise site of secretion of FSH.

.....[1]

- (b) Certain cells in the ovaries and testes have receptors for FSH in their cell surface membranes. FSH can bind with these receptors, which triggers the cells to respond to the hormone.

Mice were genetically modified so that they lacked functioning alleles of the gene that codes for the production of FSH receptors.

- (i) Female mice without FSH receptors were sterile. They were found to have normal primary and secondary follicles in their ovaries, but no Graafian (ovarian) follicles or corpora lutea.

Explain these observations.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....[4]

- (ii) Spermatozoa were collected from male mice with and without FSH receptors. The mean number of spermatozoa per mouse was estimated. The percentage of spermatozoa that could swim actively was calculated. Table 5.1 shows the results.

Table 5.1

	male mice with FSH receptors	male mice without FSH receptors
mean number of spermatozoa per mouse	5.6×10^6	3.6×10^6
percentage of spermatozoa that could swim actively	62	47

Discuss what these results suggest about the role of FSH in the development of spermatozoa in male mice.

.....

.....

.....

.....

.....

.....[3]

[Total: 8]

- 6 (a) Neurones transmit impulses from one part of a mammal's body to another.

The table contains statements that refer to motor and sensory neurones.

Complete the table, indicating with the letters **M**, **S** or **B**, whether each statement applies to:

- motor neurones only (**M**)
- sensory neurones only (**S**)
- both motor and sensory neurones (**B**).

The first one has been done for you.

statement	letter
is myelinated	B
may form a synapse with an intermediate (relay) neurone	
cell body lies within the CNS	
dendron is usually longer than axon	
cell body lies within spinal nerve	
has many dendrites	

[3]

- (b)** A synapse is a junction between two or more neurones.

Describe how an action potential arriving at a presynaptic membrane of a neurone can result in the depolarisation of the membrane of a post-synaptic neurone.

.....[5]

- (c)** Acetylcholinesterase is an enzyme found in the synaptic cleft.

Outline the role of acetylcholinesterase.

.....[2]

[Total: 10]

- 6 The Indian cobra (*Naja naja*) is a species of venomous snake found in South Asia.

Fig. 6.1 shows an Indian cobra.



Fig. 6.1

- (a) The Indian cobra's venom contains a toxin which causes muscle paralysis in mammals bitten by the snake. The toxin acts at cholinergic synapses.

Suggest ways by which the toxin in cobra venom may cause muscle paralysis.

.....

.....

.....

.....

.....

.....

..... [3]

- (b) Describe the role played by calcium ions in synaptic transmission.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (c) Synapses slow down the rate of transmission of nerve impulses but have an important role in the nervous system.

Outline **two** of the roles of synapses in the nervous system.

.....

.....

.....

.....

.....

..... [2]

[Total: 8]

- 5 (a) Fig. 5.1 shows a type of neurone found in the brain, called a pyramidal cell.

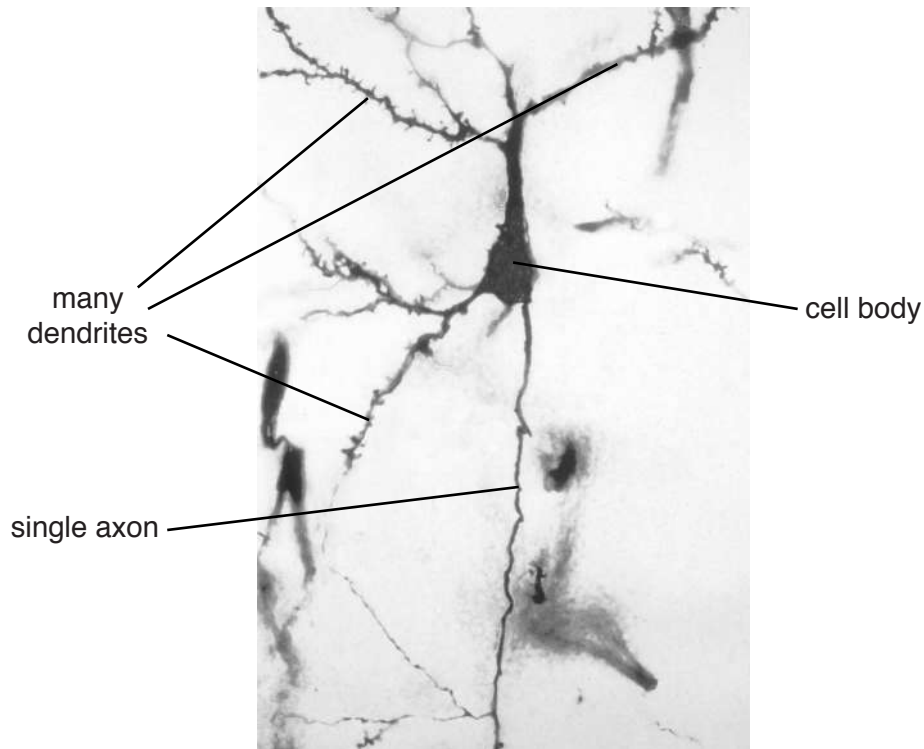


Fig. 5.1

On Fig. 5.1, draw **one** arrow to indicate the direction in which a nerve impulse will travel, as it leaves the cell body of the pyramidal cell. [1]

- (b) Fig. 5.2 shows the percentage of energy used for various processes involved in the maintenance of resting potentials and in the reception and transmission of action potentials by a pyramidal cell.

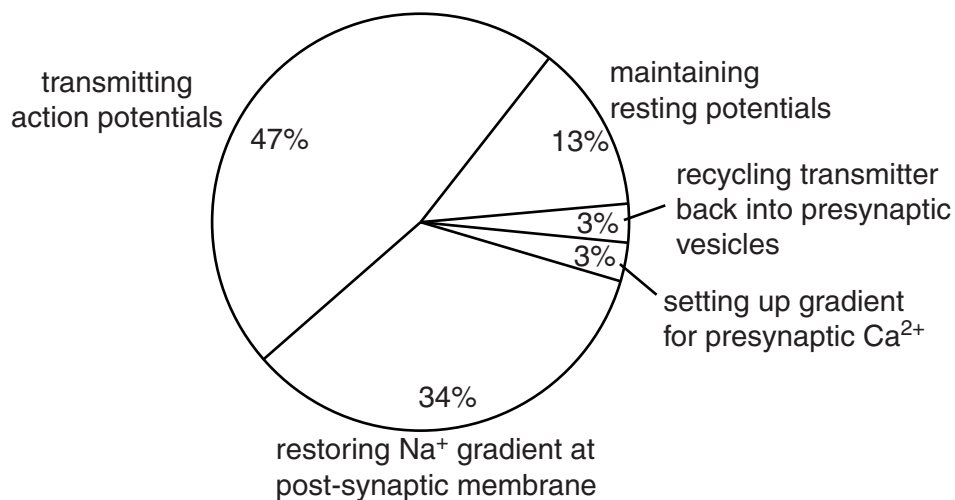


Fig. 5.2

- (i) Explain why maintaining a resting potential requires energy.

.....

.....

.....

.....

.....

.....

..... [3]

- (ii) Outline the role of calcium ions in passing on an impulse from the pyramidal cell to another neurone.

.....

.....

.....

.....

.....

.....

..... [3]

- (iii) Pyramidal cells contain large numbers of mitochondria. There are more mitochondria in each dendrite than in the axon.

With reference to Fig. 5.2, suggest reasons for this distribution of mitochondria.

.....

.....

.....

.....

..... [2]

[Total: 9]

- 6 Scorpions are predatory arthropods. They have a pair of grasping claws at the front of their bodies and a tail with a stinger. The stinger is used to inject venom into their prey to cause paralysis.

Fig. 6.1 shows a scorpion.



Fig. 6.1

(a) Scorpion venom contains two active components:

- a toxin that affects ion channels at synapses of the nervous system of their prey
- an inhibitor of an enzyme found at these synapses.

For **each** component of the venom, suggest and explain **one** way in which it may stop the correct functioning of the synapse.

toxin

.....

.....

.....

.....

inhibitor

.....

.....

.....

.....[4]

- (b) Scorpions stand very still on the sand. Moving prey will disturb grains of sand, and scorpions are able to detect this movement using sensory organs, known as slit hairs, at the tips of their legs. Some of the cells of a slit hair act as sensory receptors.

(i) State the role of a sensory receptor.

.....

.....

.....[1]

(ii) When a slit hair is bent by the movement of the sand the potential difference across the cell surface membranes of the slit hair cells becomes more positive inside compared to the outside.

State the name given to the initial change in potential difference that may lead to an action potential.

.....[1]

(iii) Action potentials may then be sent by the cells in the slit hairs to the central nervous system (CNS) of the scorpion.

Explain how the scorpion is able to distinguish between a small and a large movement of sand.

.....

.....

.....

.....

.....

.....

.....[2]

[Total: 8]

- 8 (a) Fig. 8.1 is a diagram of a sensory neurone and some receptor cells.

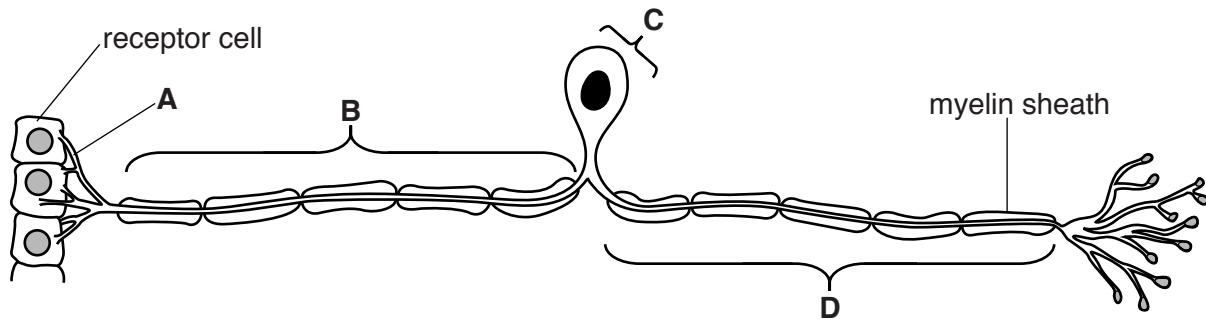


Fig. 8.1

Name the parts of the neurone labelled **A**, **B**, **C** and **D**.

- A**
- B**
- C**
- D** [4]

- (b) Explain how the myelin sheath increases the speed of conduction of nerve impulses.

.....

.....

.....

.....

.....

..... [2]

- (c) Fig. 8.2 shows the changes in the membrane potential of a sensory neurone when the receptor cells are stimulated.

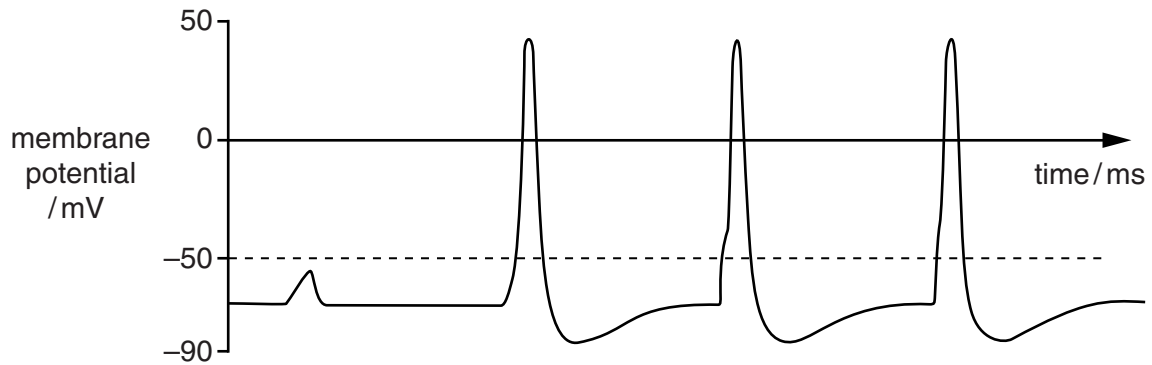


Fig. 8.2

Fig. 8.3 shows the strength of the stimuli applied to these receptor cells.

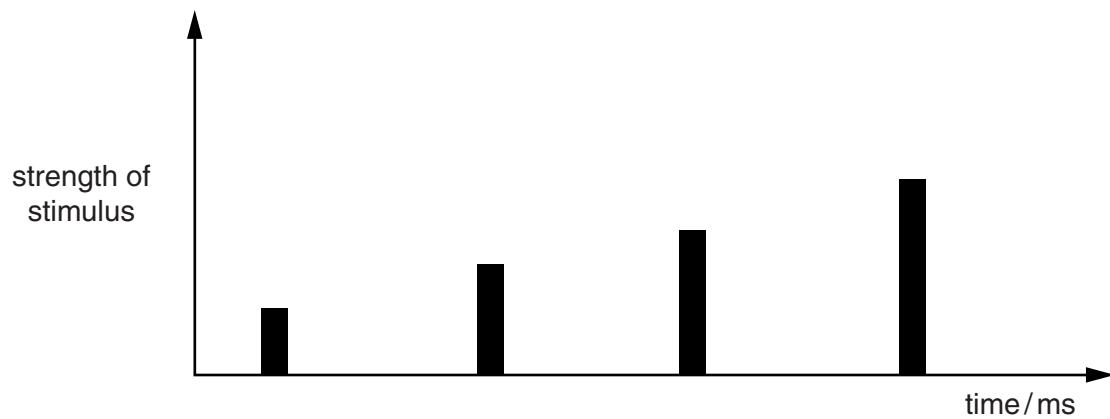


Fig. 8.3

With reference to Fig. 8.2 and Fig. 8.3, describe the relationship between the strength of the stimulus and the resulting action potential.

.....

.....

.....

.....

.....

..... [2]

[Total: 8]

- 8 (a) Fig. 8.1 is an electron micrograph of part of a cholinergic synapse.

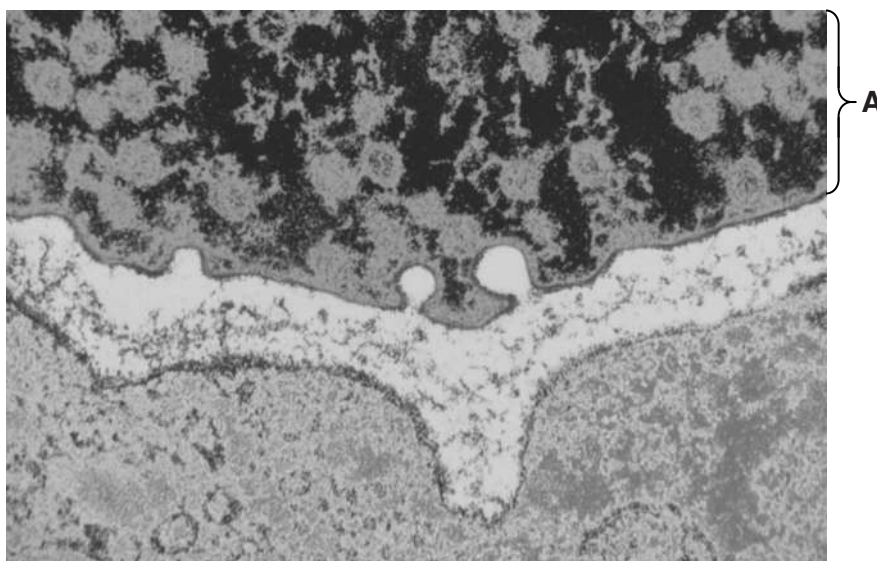


Fig. 8.1

On Fig. 8.1, use label lines and letters to label each of the following:

X – a structure that indicates that **A** is a pre-synaptic neurone

Y – an area that contains many voltage-gated Na^+ channels

Z – an area that contains both acetylcholine **and** acetylcholinesterase.

[3]

- (b) Some insecticides have a similar structure to acetylcholine. Suggest how these insecticides may affect the functioning of acetylcholinesterase.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (c) Outline the roles of synapses in the nervous system.

.....

.....

.....

.....

.....

..... [2]

9700/41/O/N/16

[Total: 8]

- 6 (a) Fig. 6.1 shows the concentration of four hormones in a woman's blood during one menstrual cycle.

concentration of hormone in
blood / arbitrary units

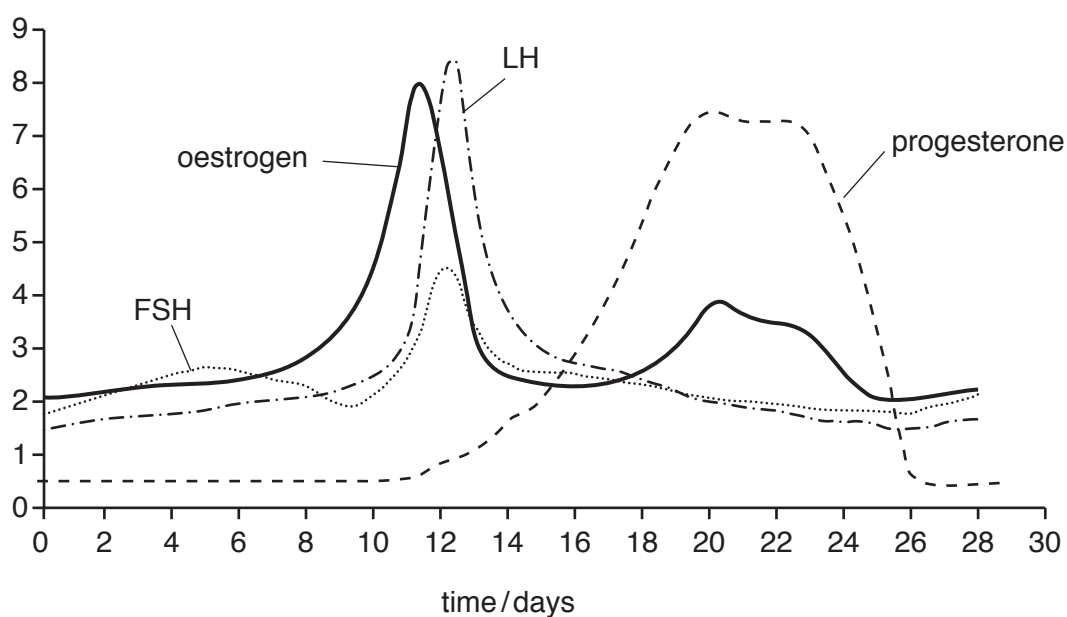


Fig. 6.1

- (i) With reference to Fig. 6.1, explain why there is a large increase in LH at around day 12.

.....

..... [1]

- (ii) State how Fig. 6.1 shows that the woman did not become pregnant during this cycle.

.....

..... [1]

(b) The combined oral contraceptive pill contains oestrogen and progesterone.

(i) Explain how this combined contraceptive pill works to prevent pregnancy.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(ii) Suggest why some women take the combined contraceptive pill for just the first 21 days of their cycles.

.....

.....[1]

(iii) Some women have a contraceptive device inserted under the skin. This releases hormones into the blood and can last for up to three years.

Suggest **one** advantage of using such a device rather than taking contraceptive pills.

.....

.....[1]

[Total: 8]

7 Fig. 7.1 shows a mammalian neuromuscular junction.

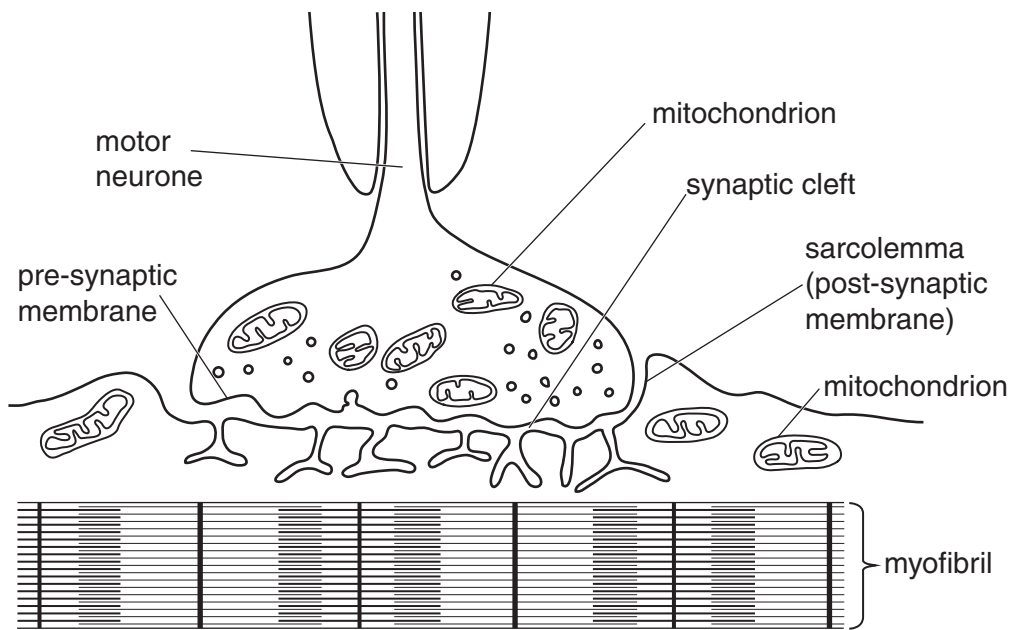


Fig. 7.1

- (a) (i)** On Fig. 7.1, use label lines and letters to label each of the following parts:

A – a region containing only actin

B – a region containing both actin and myosin.

[2]

- (ii) Outline how an action potential arriving at this neuromuscular junction can result in depolarisation of the sarcolemma.

[4]

- (b) Table 7.1 shows some of the events occurring during muscle contraction. They are **not** listed in the correct order.

Table 7.1

event	description of event
Q	Ca ²⁺ ions diffuse out of sarcoplasmic reticulum
R	myosin heads bind to actin
S	sarcolemma depolarised
T	sarcomere shortens
U	Ca ²⁺ ions bind to troponin
V	transverse tubules depolarised
W	binding sites on actin exposed
X	myosin heads tilt
Y	tropomyosin moves
Z	troponin changes shape

Complete Table 7.2 to show the **correct** order of the events. Two of the events have been completed for you.

Table 7.2

correct order	letter of event
1	
2	
3	
4	
5	Z
6	
7	
8	
9	
10	T

[4]

- 8 (a) When a dormant seed absorbs water it will start to germinate and its rate of respiration will increase.

Name the plant growth regulator involved in the initiation of germination of seeds.

.....[1]

- 6 (a) Fig. 6.1 shows the concentration of two hormones, oestrogen and progesterone, in a woman's blood during one menstrual cycle.

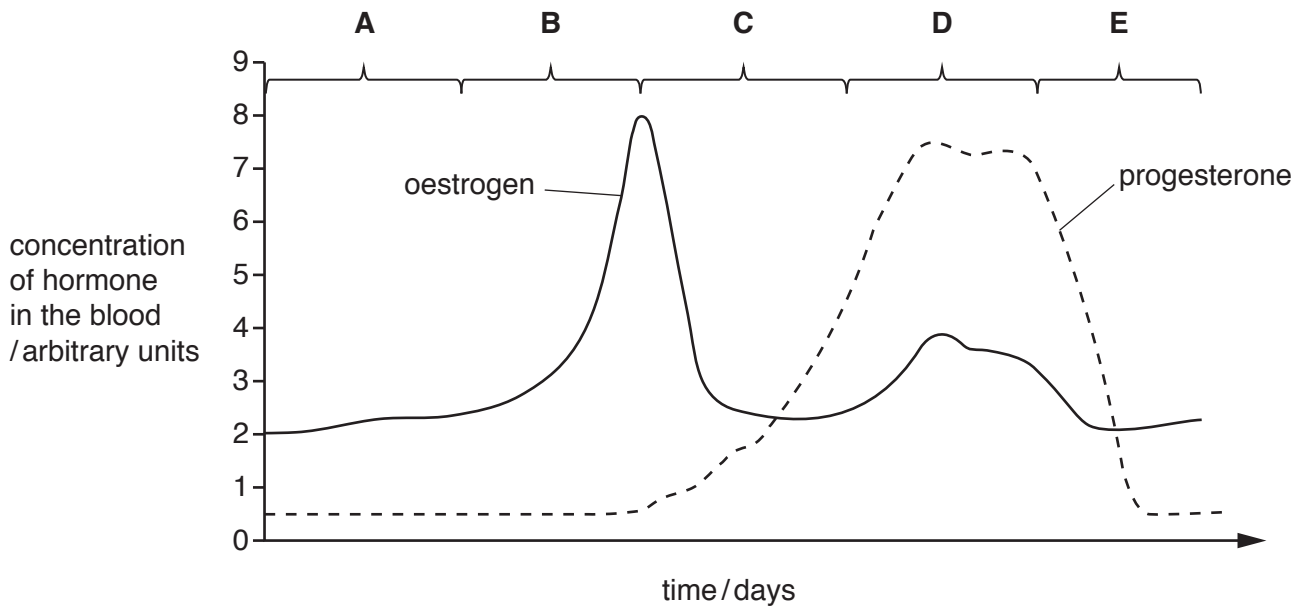


Fig. 6.1

- (i) With reference to Fig. 6.1, state the letter of the stage of the cycle during which ovulation occurs.

.....[1]

- (ii) State how Fig. 6.1 shows that the woman did not become pregnant during this cycle.

.....
[1]

- (iii) Name the ovarian structure that secretes progesterone after ovulation.

.....[1]

- (iv) State the role of progesterone during stage D.

.....

[1]

- (b) The combined contraceptive pill contains oestrogen and progesterone.

Explain how this combined contraceptive pill works to prevent pregnancy.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 8]

- 7 (a)** Fig. 7.1 is an electron micrograph of a section of striated muscle.

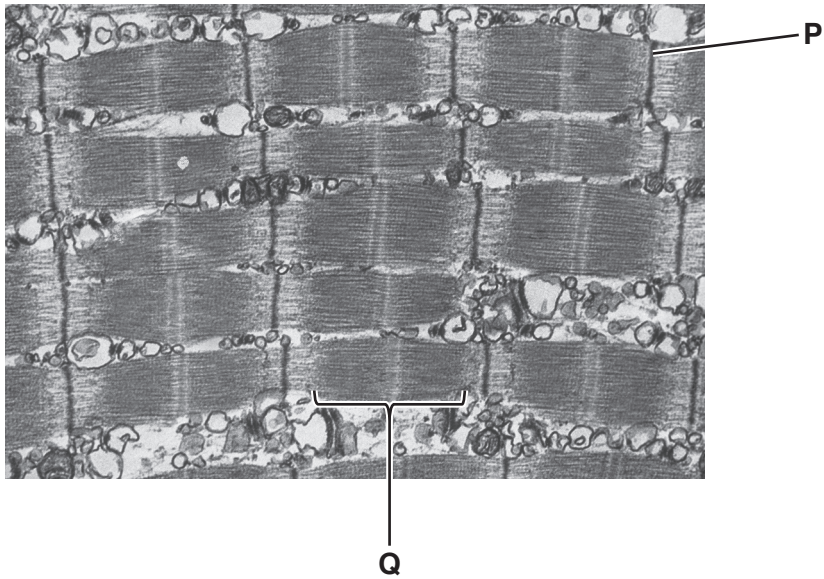


Fig. 7.1

Name structure **P** and the region represented by **Q**.

P

Q. _____

[2]

- (b)** Describe the role of calcium ions (Ca^{2+} ions) in the shortening of a sarcomere.

.....[5]

- (c) A motor end plate of a neuromuscular junction is part of a modified cholinergic synapse.

Explain why mitochondria are present in the motor end plate of a neuromuscular junction.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

9700/41/M/J/17

[Total: 10]

- 6 (a) Describe how tropomyosin and myosin are each involved in the sliding filament model of muscle contraction.

(i) *tropomyosin*

.....

.....

.....

..... [2]

(ii) *myosin*

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b) Striated muscle is made up of many specialised muscle cells known as muscle fibres or myocytes.

There are two different types of muscle fibre in striated muscle:

- fast twitch muscle fibres that contract quickly, but rapidly fatigue (get tired)
- slow twitch muscle fibres that contract slowly and continue to contract for a long time.

Table 6.1 shows some features of fast twitch and slow twitch muscle fibres.

Table 6.1

feature	fast twitch fibre	slow twitch fibre
respiration	mainly anaerobic	mainly aerobic
glycogen concentration	high	low
capillaries	few	many

Use the information in Table 6.1 to suggest **and** explain **one** advantage of:

- (i) the high glycogen concentration in fast twitch fibres

.....

.....

.....

.....

..... [2]

- (ii) many capillaries supplying slow twitch fibres.

.....

.....

.....

.....

..... [2]

[Total: 10]

- 3 Fig. 3.1 shows a diagram of two sarcomeres of relaxed striated muscle.

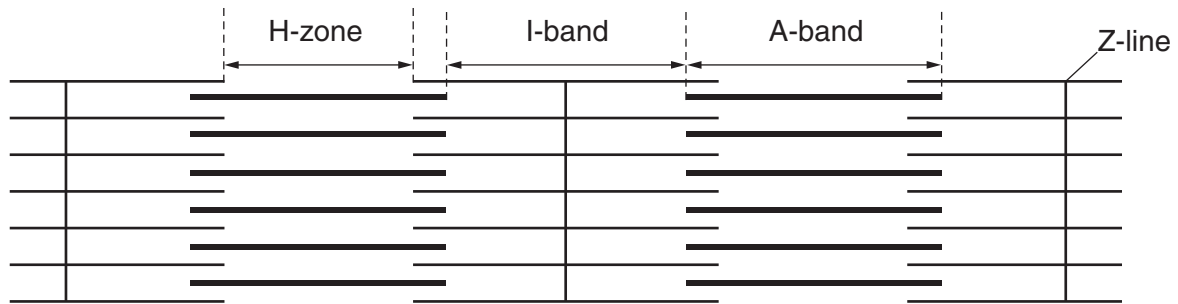


Fig. 3.1

- (a) When the striated muscle contracts, state what happens to the length of:
- the I-band [1]
 - the A-band. [1]
- (b) Describe how the response of the sarcoplasmic reticulum to the arrival of an action potential leads to the contraction of striated muscle.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (c) Glycogen storage disease type V (GSDV) is a metabolic disorder where stored glycogen cannot be broken down to release glucose, resulting in the production of only small quantities of ATP. People with GSDV are unable to exercise normally, as the lack of ATP affects the functioning of striated muscle.

With reference to the sliding filament model of muscular contraction, suggest why a **lack** of ATP affects the functioning of striated muscle.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

- 5 (a)** Explain the importance of the myelin sheath in the transmission of action potentials.

[4]

- (b)** Acetylcholine is a neurotransmitter.

Describe the events that occur at a synapse that lead to the release of acetylcholine.

[5]

[Total: 9]

- 6 Cloves are the aromatic flower buds of the tree *Syzygium aromaticum*. Eugenol is a drug extracted from cloves.

Eugenol affects the movement of sodium ions through the cell surface membranes of sensory neurones.

- (a) Fig. 6.1 shows the effect of eugenol concentration on the percentage decrease in sodium ion movement.

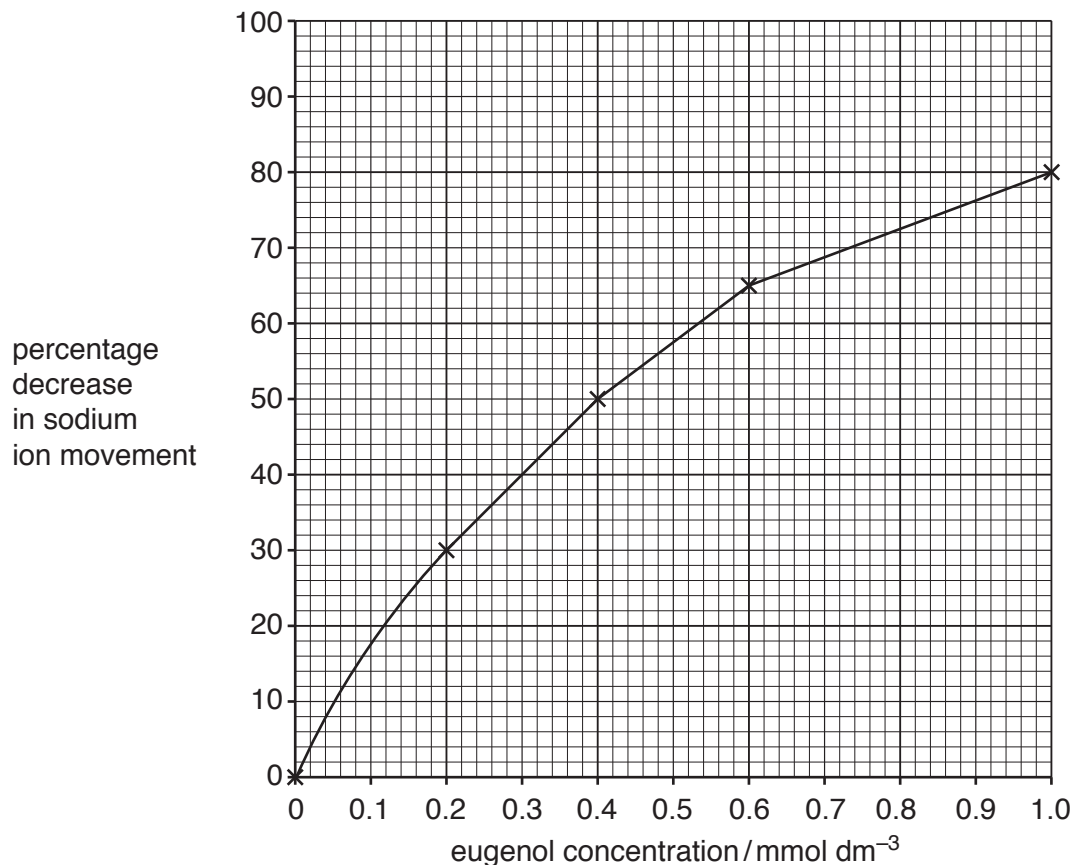


Fig. 6.1

- (i) Describe the effect of eugenol concentration on the percentage decrease in sodium ion movement.

.....

 [2]

- (ii) Using Fig. 6.1, determine the percentage decrease in sodium ion movement at a eugenol concentration of 0.5 mmol dm⁻³.

percentage decrease % [1]

- (b)** Eugenol can be used to relieve the pain of toothache by putting it onto the affected tooth and gum.

Suggest **and** explain how the action of eugenol may reduce pain.

.....[5]

[Total: 8]

- 8 (a) In mammals, the nervous system and the endocrine system coordinate responses to the changes in internal and external environments.

Complete Table 8.1 to indicate the differences between the nervous system and the endocrine system.

Table 8.1

feature	nervous system	endocrine system
method of communication		
method of transmission		
transmission speed		
duration of effect		

[4]

- (b) Fig. 8.1 shows the changes in the concentration of hormones in the blood during the menstrual cycle.

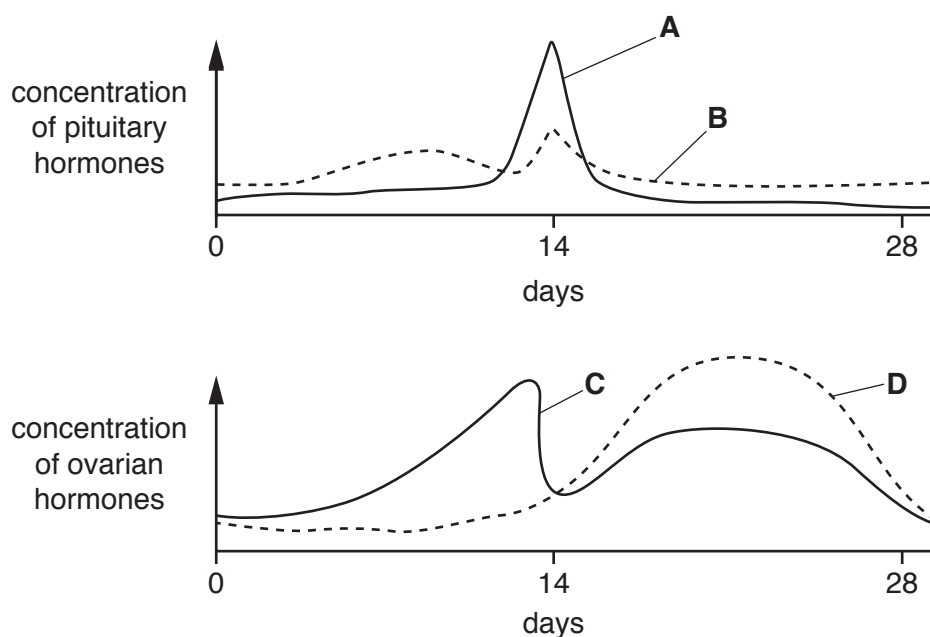


Fig. 8.1

With reference to Fig. 8.1, match hormones **A**, **B**, **C** or **D** to the correct statements 1 to 4.

Each hormone may be used once, more than once or not at all.

- 1 made by the corpus luteum
- 2 stimulates the repair of the endometrium
- 3 maintains the endometrium
- 4 stimulates ovulation

[4]

(c) Outline the biological basis for contraceptive pills containing oestrogen and progesterone.

[5]

[Total: 13]

- 8 (a) Describe how an action potential arriving at a presynaptic neurone can result in the release of acetylcholine into the synaptic cleft.

.....

.....

.....

.....

.....

.....

.....

.....[4]

- (b) Lidocaine is a local anaesthetic drug which blocks voltage-gated Na^+ channels in the postsynaptic membrane of a synapse.

Explain the effect of lidocaine action on the postsynaptic neurone.

.....

.....

.....

.....

.....[2]

(c) Fig. 8.1 is a diagram of a neuromuscular junction.

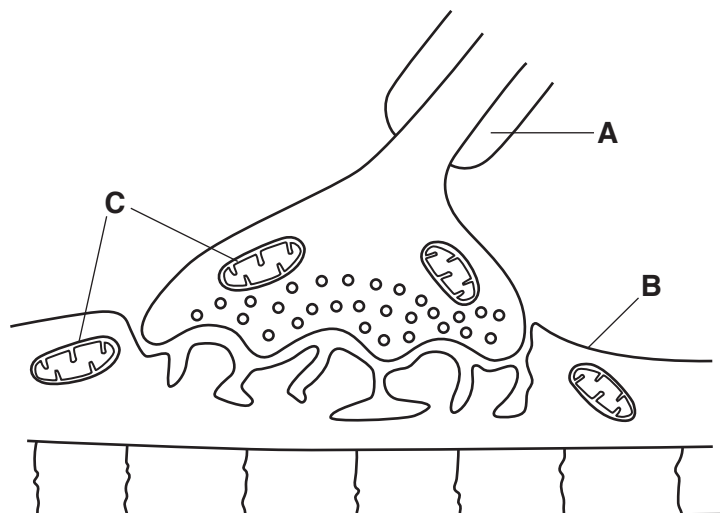


Fig. 8.1

(i) With reference to Fig. 8.1, name structures **A**, **B** and **C**.

A

B

C [3]

(ii) Outline the importance of structure **A** in the transmission of nerve impulses.

.....

 [2]

(iii) Explain why the structures labelled **C** are needed in a neuromuscular junction.

.....

 [4]

[Total: 15]

- 8 (a)** Striated muscle is made of many fibres. Each fibre is composed of myofibrils.

The striated appearance of the muscle fibre is due to the arrangement of two types of protein filaments, thick filaments and thin filaments, within the sarcomeres of the myofibril.

Describe the main structural features of thick filaments and thin filaments in the sarcomere.

thick filaments

.....

.....

thin filaments

.....

.....

.....4

- (b)** Describe the role of calcium ions in the contraction of striated muscle.

.....

.....

.....

.....

[5]

- (c) Muscle cells sometimes have to carry out respiration in anaerobic conditions.

Describe how respiration occurs in anaerobic conditions in a muscle cell **and** state why it is important that this process occurs.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

[Total: 13]

- 8 (a) Outline the roles of sensory receptor cells in the mammalian nervous system.

.....

.....

.....

.....

.....

.....

..... [3]

- (b) Fig. 8.1 shows the changes in potential difference (p.d.) across the membrane of a receptor cell over a period of time. The membrane was stimulated at time **A** and at time **B** with stimuli of different intensities.

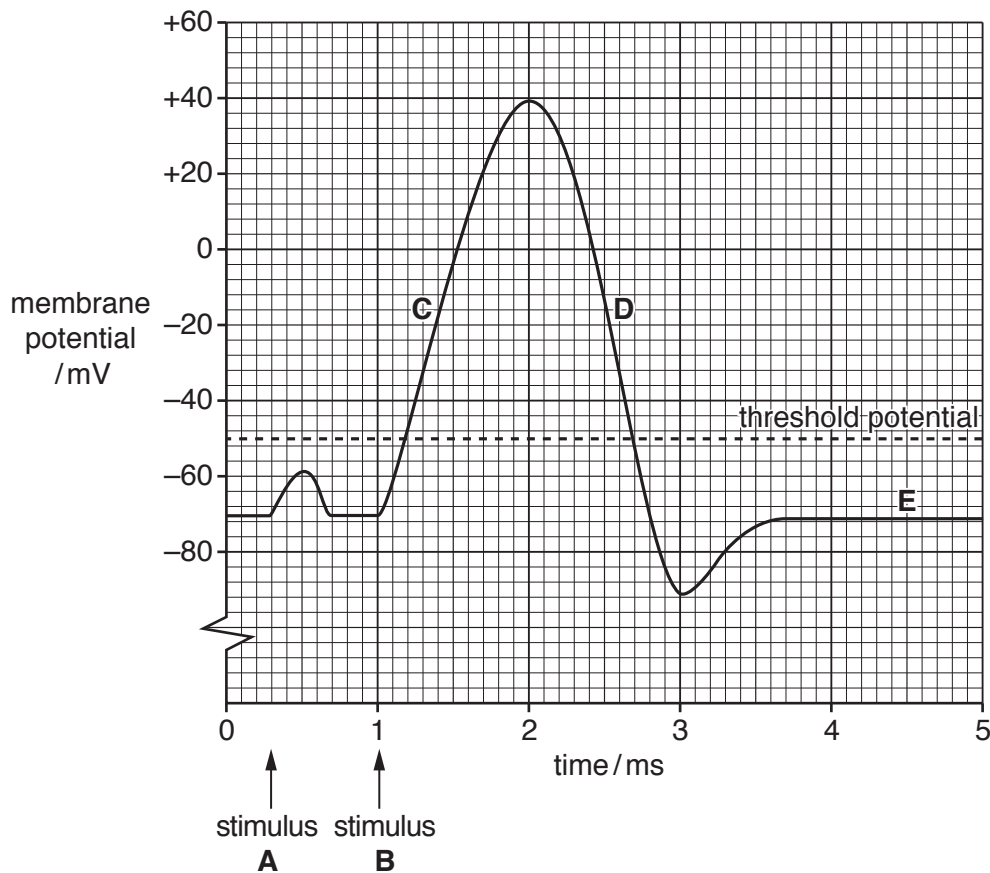


Fig. 8.1

- (i) State which of the letters **C**, **D** and **E** on Fig. 8.1 correspond to each of these events. You may use each of the letters **C**, **D** or **E** once, more than once or not at all.

The Na^+/K^+ pump is operating

The voltage-gated Na^+ channels are open

The voltage-gated K^+ channels are open

[3]

- (ii) Explain why stimulus **A** did not result in an action potential being produced whereas stimulus **B** did.

.....

 [2]

- (iii) Describe the importance of the refractory period in the transmission of action potentials.

.....

 [2]

- (iv) Describe how action potentials are transmitted along a myelinated axon.

.....

 [4]

[Total: 14]

- 4 (a) Fig. 4.1 shows a transmission electron micrograph of a section through striated muscle.

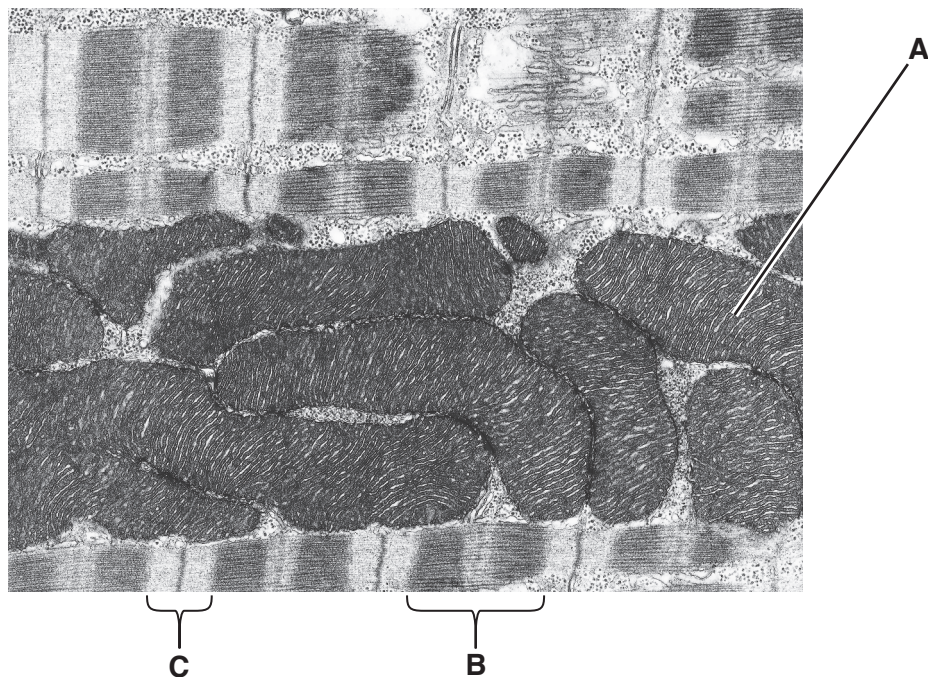


Fig. 4.1

Complete Table 4.1, using the letters **A**, **B** or **C**, to show the location of proteins associated with striated muscle structure.

You may use each letter once, more than once, or not at all.

Table 4.1

protein	location
myosin and actin	
actin alone	
ATP synthase	
ATPase	

[4]

(b) Explain the role of ATP in the contraction of striated muscle.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 9]

8 Gibberellin is a plant growth hormone that has a role in germination and in stem elongation.

(a) Outline how gibberellin is involved in activating genes for stem elongation.

.....

.....

.....

.....

.....[2]

(b) Outline the role played by gibberellin in the germination of wheat seeds.

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(c) The length of stem in pea plants is controlled by a single gene. Pea plants can be either tall or short.

A study was carried out to investigate the effect of applying gibberellin to short pea plants. Two groups of short pea seedlings were used, group **P** and group **Q**.

- Group **P** consisted of 20 seedlings to which a paste containing gibberellin had been applied two days after germination.
- Group **Q** consisted of 20 seedlings to which a paste **without** gibberellin had been applied two days after germination.
- The length of stem of the pea plants was recorded at intervals over 20 days.

The results are shown in Fig. 8.1.

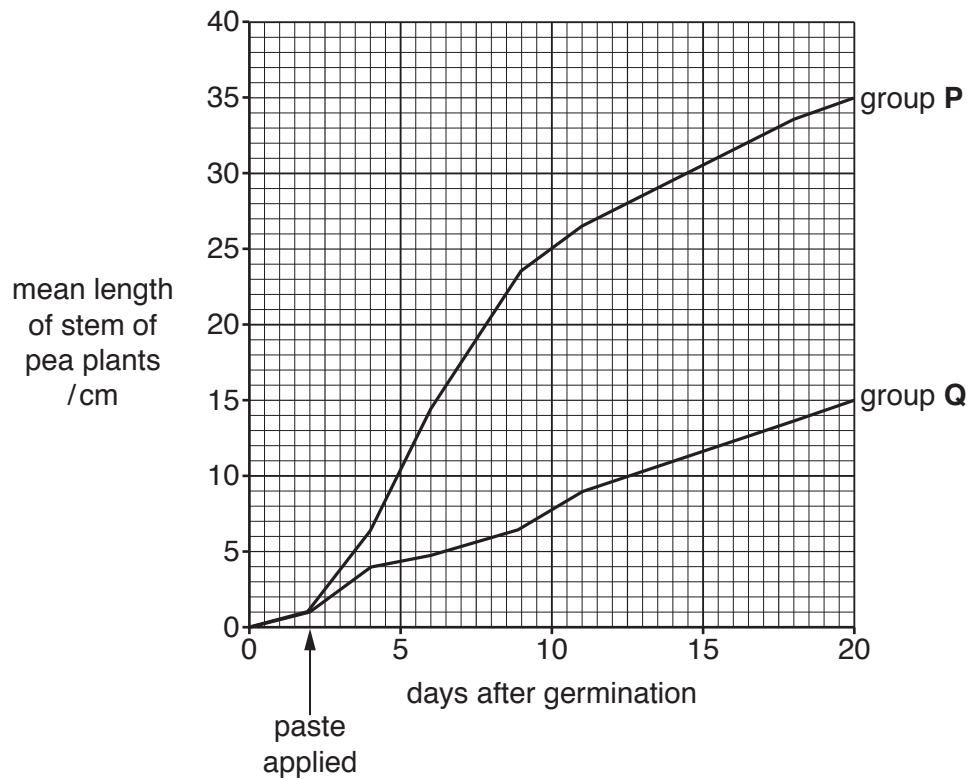


Fig. 8.1

With reference to Fig. 8.1, describe the results of the investigation **and** compare the growth rate of plants in group **P** and group **Q**.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[4]

(d) Explain the role of the gene controlling stem length in pea plants.

.....

.....

.....

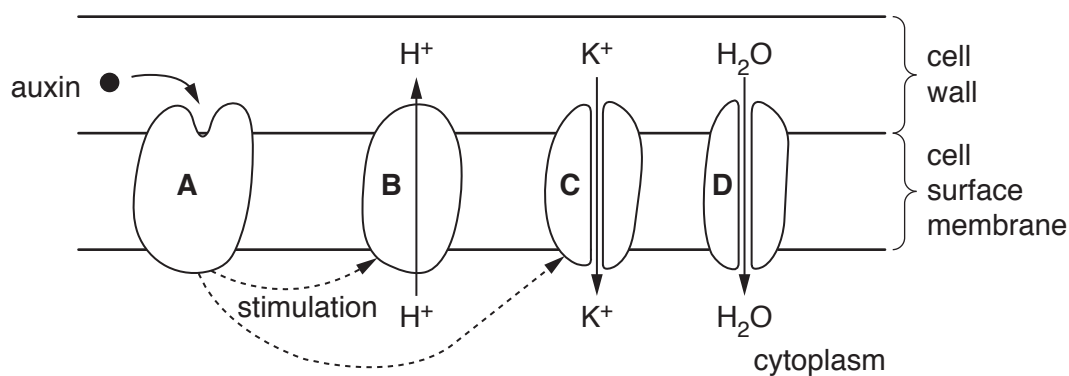
.....

.....

.....[3]

[Total: 13]

- 1 (a) Fig. 1.1 shows part of a cell in a growing region of a plant.



not to scale

Fig. 1.1

- (i) State the **type** of protein represented by **A**.

..... [1]

- (ii) Proteins **B**, **C** and **D** are transport proteins.

Identify proteins **B**, **C** and **D**.

B

C

D

[3]

- (b) Describe the effects on the cell wall of many hydrogen ions moving into the cell wall.

.....

.....

.....

.....

.....

.....

.....

..... [3]

(c) Explain the consequences of an influx of potassium ions into the cell.

.....

.....

.....

.....

..... [2]

[Total: 9]

- 1 (a) Fig. 1.1 is an electron micrograph showing a cross-section of a myelinated neurone.



Fig. 1.1

Name **A** and **B**.

A

B

[2]

- (b) Explain what is meant by saltatory conduction **and** describe its effect on the transmission of a nerve impulse.

.....
.....
.....
.....
.....
.....

[3]

- (c) A type of sea snail, *Conus purpurascens*, produces a toxin that blocks calcium ion channels in the presynaptic knob of a cholinergic synapse. The presence of this toxin results in no action potentials in the postsynaptic neurone.

Explain why the presence of this toxin results in **no** action potentials in the postsynaptic neurone.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 10]

- 1 (a) Fig. 1.1 shows a cholinergic synapse.

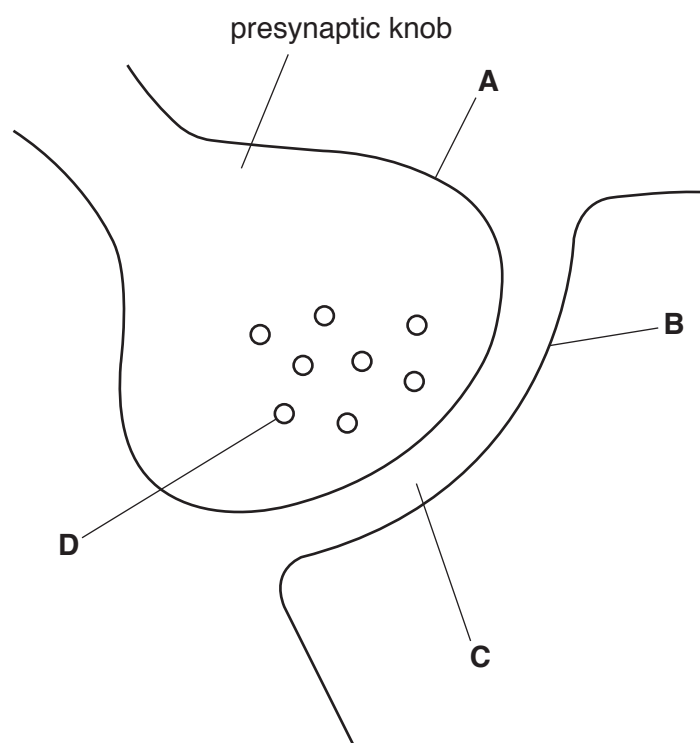


Fig. 1.1

Complete Table 1.1, using the letters **A**, **B**, **C** or **D** from Fig. 1.1, to show the location of compounds and structures associated with a cholinergic synapse.

You may use **A**, **B**, **C** and **D** once, more than once, or not at all.

Table 1.1

compound or structure	location
acetylcholine	
voltage-gated channel	
receptor protein	
acetylcholinesterase	

[4]

(b) Explain what is meant by a voltage-gated channel.

.....

.....

.....

..... [2]

(c) Explain the role of acetylcholinesterase in a synapse.

.....

.....

.....

.....

.....

..... [3]

(d) Outline the roles of synapses in the nervous system.

.....

.....

.....

.....

..... [2]

[Total: 11]

- 7 The Venus fly trap, *Dionaea muscipula*, is a carnivorous plant, native to wetlands of the East Coast of the USA. Mineral ions from decayed organisms are often washed away in these wetlands.

Fig. 7.1 shows a Venus fly trap leaf.

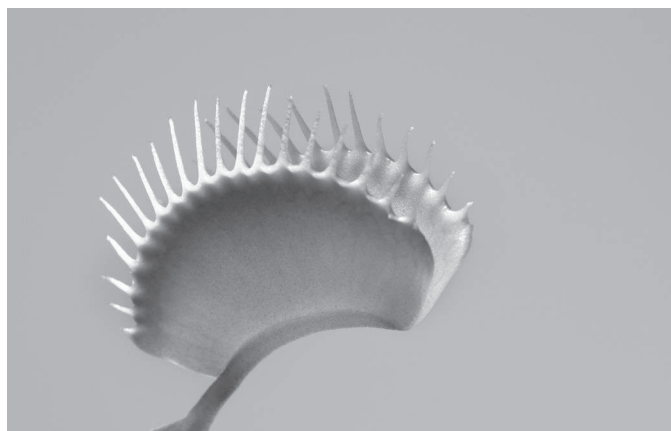


Fig. 7.1

- (a) Suggest why a Venus fly trap benefits from catching insects in these wetlands.

.....
.....
.....
..... [2]

- (b) (i) The leaves of the Venus fly trap will close if stimulated by an insect.

State which part of the leaf detects the stimulus.

..... [1]

- (ii) Explain how the plant does not waste energy by closing when it does not need to, such as when a large drop of rain touches the receptor.

.....
..... [1]

(c) Fig. 7.2 is a graph of an action potential in a human neurone.

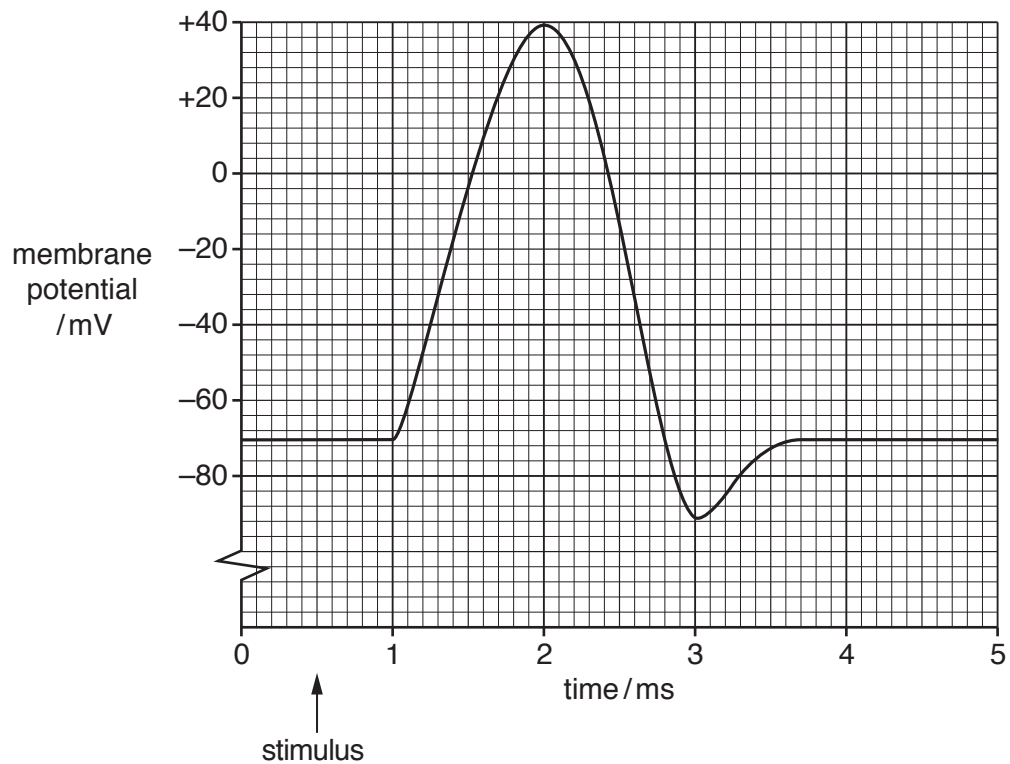


Fig. 7.2

Fig. 7.3 is a graph of an action potential in leaf cells of a Venus fly trap.

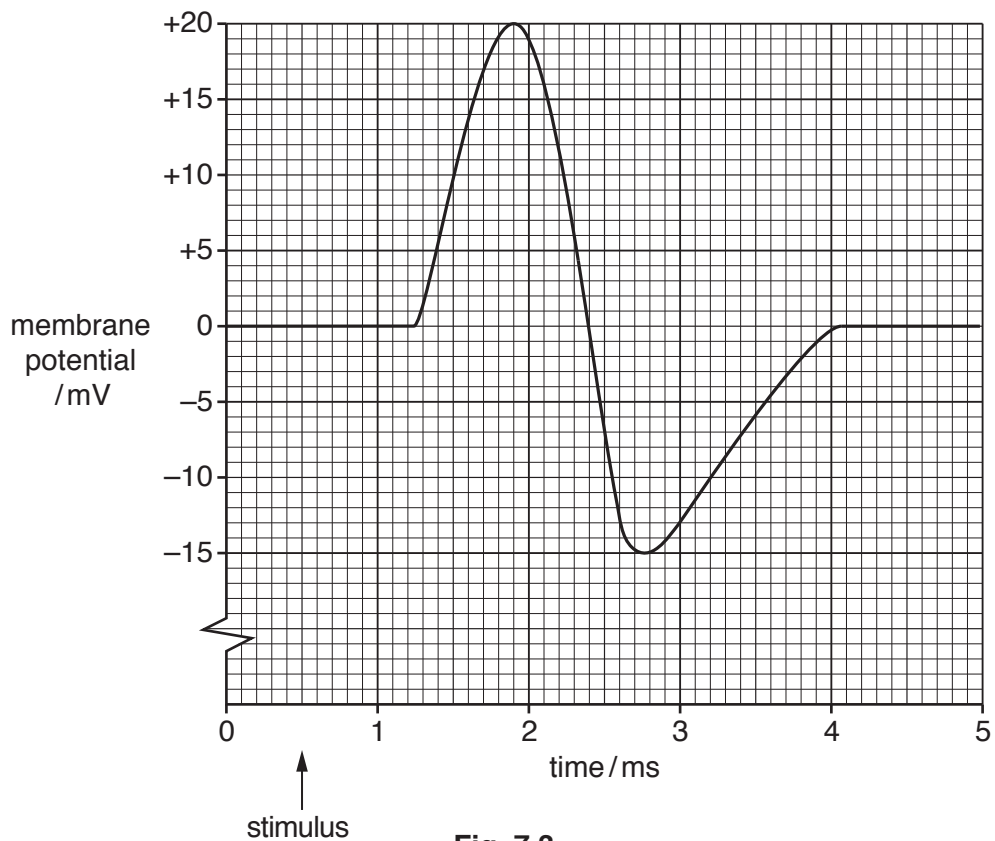


Fig. 7.3

With reference to Fig. 7.2 and Fig. 7.3, describe how the action potential of the Venus fly trap differs from that of a human.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (d) Describe how the production of action potentials in the leaf cells of the Venus fly trap can result in the leaves closing and trapping an insect.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

[Total: 12]

7 (a) Gibberellin is involved in the germination of barley seeds.

In an investigation, aleurone layers from barley seeds were extracted. One sample was treated with gibberellin and the other sample was given no gibberellin treatment. The rate of production of amylase enzyme by the aleurone layers was measured over 15 hours.

The results are shown in Fig. 7.1.

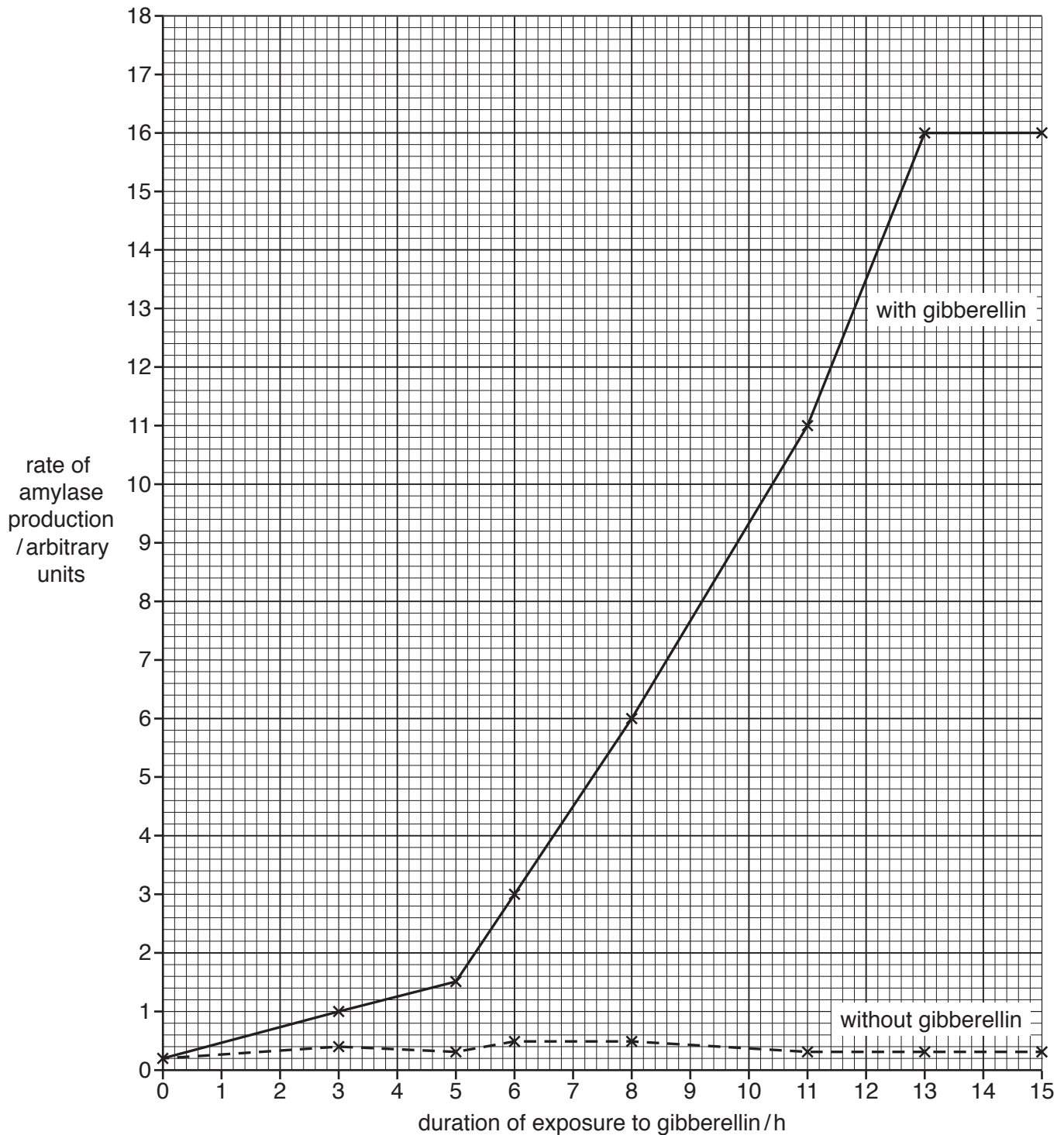


Fig. 7.1

Describe the results shown in Fig. 7.1.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Explain why the aleurone layers of barley seeds need to produce amylase during germination.

.....

.....

.....

.....

.....

..... [3]

(c) The height of some plants is partly controlled by their genes. Height in pea plants is affected by a gene with two alleles. The dominant allele results in the production of active gibberellin, which stimulates stem elongation.

(i) State the symbol that represents the dominant allele.

..... [1]

(ii) Explain how this dominant allele results in the production of active gibberellin.

.....

.....

.....

.....

..... [2]

- 6(e)** The striated muscle of the sea otter is composed of fibres called myofibrils. Myofibrils are made of units called sarcomeres.

Describe the proteins that are involved in the contraction of a sarcomere.

.....

.....

.....

.....

.....

.....

.....

..... [4]

- 6 (a) Thyrotoxic myopathy (TM) is a neuromuscular disorder caused by overproduction of the thyroid hormone thyroxine. One of the main symptoms of TM is muscle fatigue.

Fig. 6.1 outlines the effects of overproduction of thyroxine on striated muscle.

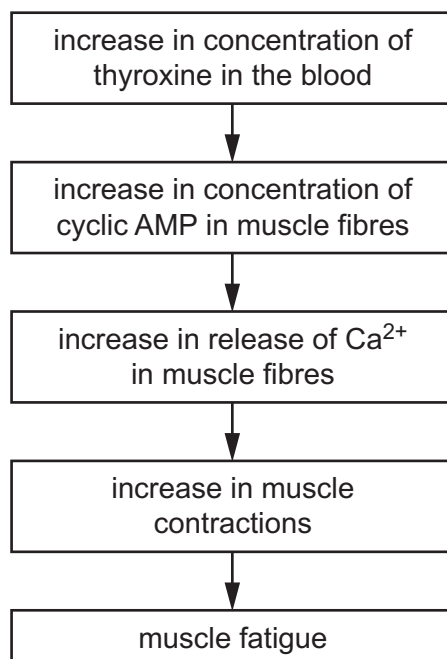


Fig. 6.1

- (i) The concentration of thyroxine in the blood usually fluctuates around a set point.

Name the mechanism that keeps the concentration of thyroxine in the blood close to its set point.

..... [1]

- (ii) Name the part of the striated muscle fibre that releases Ca²⁺.

..... [1]

- (iii) Describe the role of Ca^{2+} , troponin and tropomyosin in the contraction of striated muscle.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (iv) Cyclic AMP (cAMP) is also involved in the response of liver cells to glucagon.

Describe the role of cAMP in the response of liver cells to glucagon.

.....

.....

.....

..... [2]

- (b) An increase in the concentration of thyroxine in the blood can lead to a condition called insulin resistance (IR). IR decreases the sensitivity to insulin of target cells, such as muscle and liver cells.

Suggest how decreased sensitivity to insulin affects target cells.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

- 6 (a) (i)** Identify the precise location in a cholinergic synapse that is described in each of the statements.

A region that contains many mitochondria.

.....

A region where exocytosis of ACh occurs.

.....

A region that contains voltage-gated channel proteins.

.....

A region that contains ligand-gated channel proteins.

.....

[4]

- (ii)** Outline the roles of synapses in the nervous system.

.....

.....

.....

..... [2]

- (b)** Some insecticides contain compounds called organophosphates. Organophosphates can act as enzyme inhibitors in neuromuscular junctions.

People who use organophosphates and do not follow safety guidelines are at risk of organophosphate poisoning, which affects muscle function.

Suggest how organophosphates could affect muscle function in humans.

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (c) Outline the role of the sarcoplasmic reticulum in the contraction of striated muscle.

.....

.....

.....

.....

..... [2]

[Total: 12]

- 6 (a) A person who has a wound to their skin may experience pain. Opioid drugs can be taken to relieve the pain.

Opioid receptors are located in the presynaptic membrane of a cholinergic synapse.

Fig. 6.1 shows the action of an opioid drug on the presynaptic membrane.

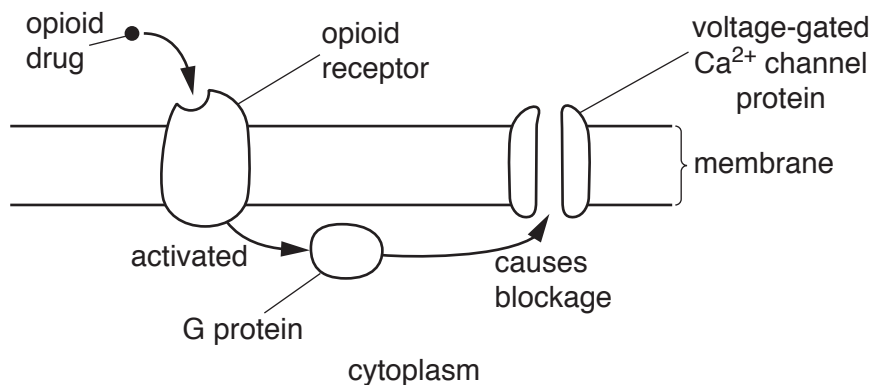


Fig. 6.1

Explain how the action of an opioid drug on the presynaptic membrane can prevent the generation of pain impulses in the postsynaptic neurone.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Spinal reflexes help the body to respond very quickly to potentially dangerous situations that could cause injury.

(i) State **two** features of a spinal reflex, **other than** being fast.

.....

.....

.....

..... [2]

(ii) Sensory and motor neurones are involved in a spinal reflex.

State the location of the cell body of a sensory neurone **and** a motor neurone.

sensory neurone

motor neurone [2]

(iii) Describe the function in a spinal reflex of a sensory neurone **and** a motor neurone.

sensory neurone

.....

.....

.....

motor neurone

.....

.....

..... [4]

[Total: 13]

5(b) The Venus fly trap is a plant that is able to capture and digest insects. It has modified leaves, which have sensory hairs that respond to touch. When an insect comes into contact with the hairs, receptor potentials are generated.

- (i) Name the ion that moves into the cells at the base of the sensory hairs to generate receptor potentials.

..... [1]

- (ii) If two or more of these hairs are stimulated within a period of 20–35 seconds, action potentials are generated, causing the leaf to close quickly and trap the insect.

Suggest why it is beneficial to the plant for stimulation of two or more hairs to be necessary before the leaf will close.

.....
..... [1]

- (iii) The trapped insect is digested by enzymes released from the leaf cells.

Name the mechanism by which the enzymes are released.

..... [1]

- (iv) Suggest why Venus fly trap plants need to capture insects.

.....
.....
..... [1]

[Total: 10]

- 6** Dogs have an exceptionally good sense of smell. They can detect molecules in the air with a concentration of one part per trillion (10^{12}).
- (a)** Olfactory receptor cells are the sensory receptors in the nasal cavity that respond to chemicals in the air. They function in a similar way to the chemoreceptor cells in the taste buds of the tongue.

Describe how olfactory receptor cells in the nasal cavity of dogs respond to chemicals to generate an action potential.

[5]

5 (a) Nerves consist of bundles of different types of neurones.

Fig. 5.1 shows the mean transmission speed of impulses for three types of sensory neurone, **C**, **A^δ** and **A^β**.

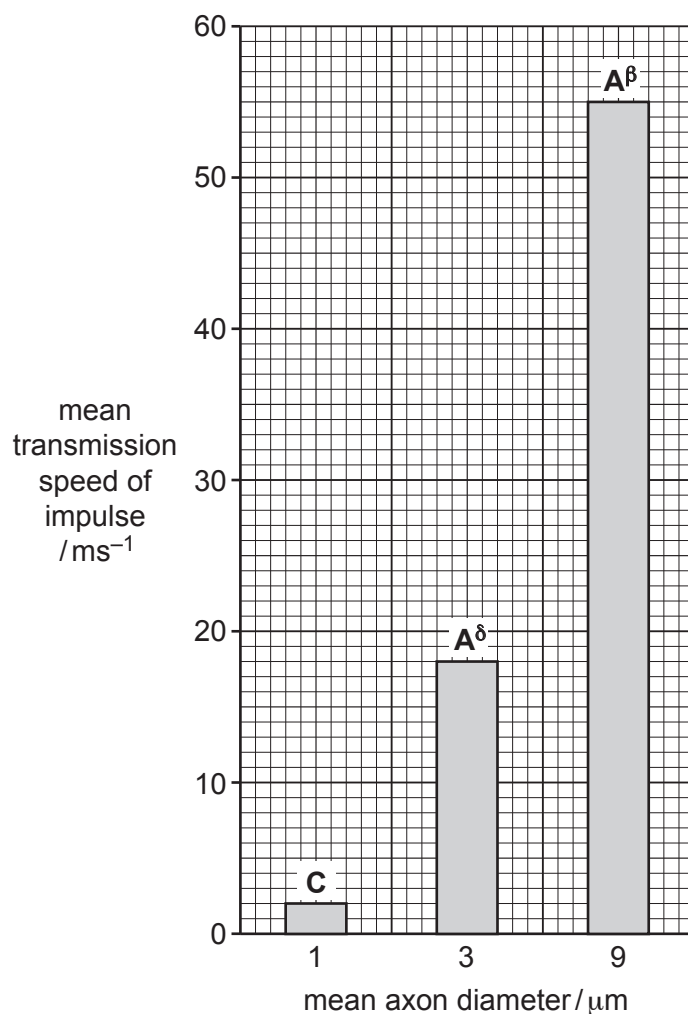


Fig. 5.1

- Impulses from pain receptors in the skin are sent along sensory neurones **C** and **A^δ**.
- Sensory neurones **C** and **A^δ** synapse in the spinal cord with relay neurones known as projection neurones.
- Projection neurones send impulses to the part of the brain that perceives pain.
- Impulses from touch receptors in the skin pass along sensory neurones **A^β**, which can also synapse with the projection neurones in the spinal cord.
- Sensory neurones **A^δ** and **A^β** are myelinated.
- Sensory neurones **C** are unmyelinated.

- (i) Describe the results shown in Fig. 5.1 **and** suggest explanations for these results.

.....

.....

.....

.....

.....

.....

..... [3]

- (ii) Gently rubbing a damaged area of skin can reduce the perception of pain.

Suggest an explanation for this.

.....

.....

..... [1]

- (b) Back pain in humans can be reduced by using a transcutaneous electrical nerve stimulation (TENS) machine.

A TENS machine uses electrical impulses to stimulate nerve endings near the site of the pain.

It is thought that TENS triggers the release of natural painkillers called endorphins at synapses.

Fig. 5.2 shows synapses in a pain pathway.

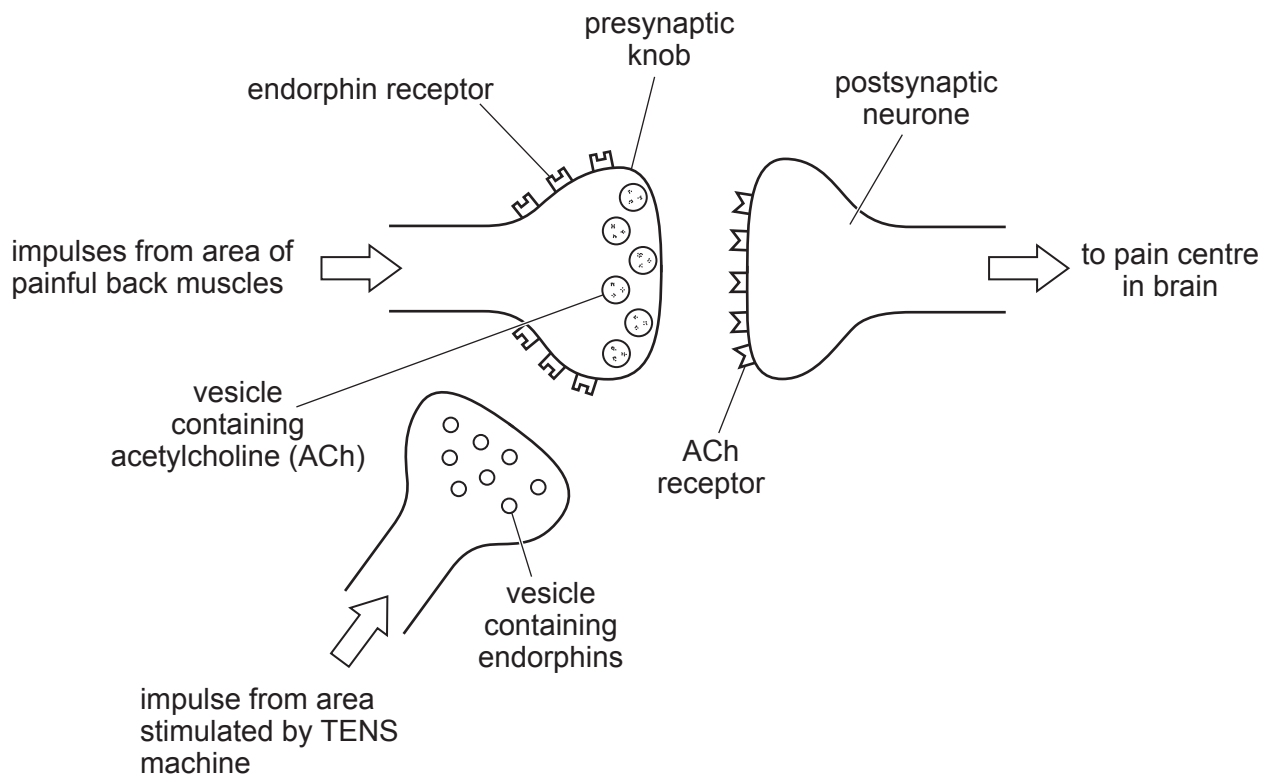


Fig. 5.2

- (i) Suggest **and** explain how endorphins may act to reduce pain.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (ii) Suggest **one disadvantage** of using pharmaceutical drugs for reducing pain compared to using TENS.

.....

..... [1]

[Total: 9]

- 1 (a) Fig. 1.1 is a diagram of part of a neurone membrane at resting potential.

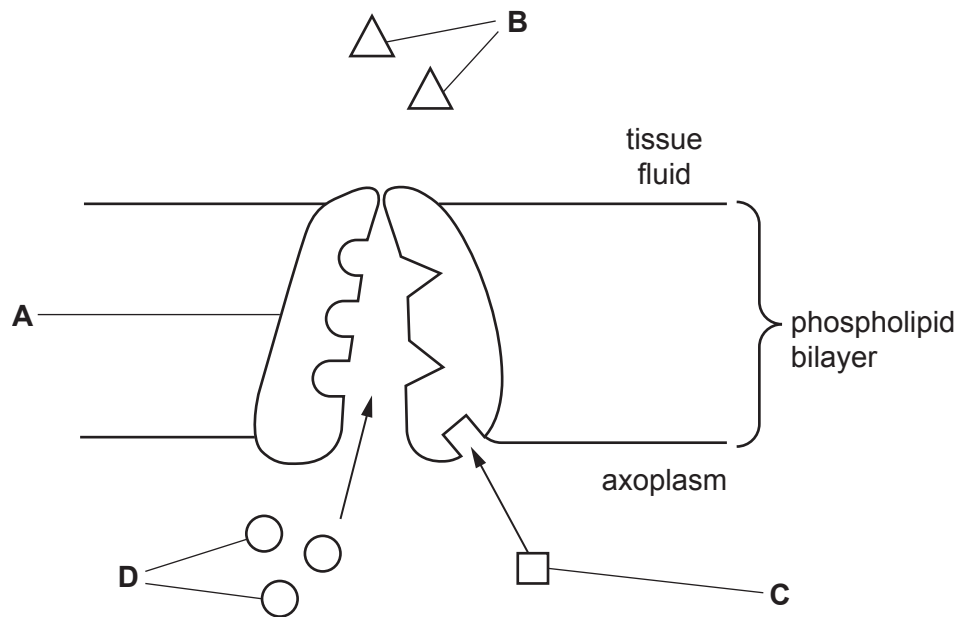


Fig. 1.1

- (i) With reference to Fig. 1.1, name **A**, **B**, and **D**.

A

B

D [3]

- (ii) Substance **C** is required to make structure **A** function.

Name substance **C**.

..... [1]

- (b)** Some drugs can affect the functioning of neuromuscular junctions or cholinergic synapses.

Table 1.1 lists three drugs and describes their action on neuromuscular junctions or cholinergic synapses.

Table 1.1

drug	action of drug
curare	blocks muscle cell membrane receptors at neuromuscular junctions
nerve gas	inhibits acetylcholinesterase function in synapses
alcohol	inhibits exocytosis of neurotransmitters in synapses

Suggest **and** describe the immediate consequence of the action of each drug on a neuromuscular junction or cholinergic synapse.

..... [5]

[Total: 9]

-

A

B

C

D

[4]

[4]

- (c) When a mammal dies, aerobic respiration stops. The striated muscles contract and remain contracted for a few hours after death.

Suggest why the muscles remain contracted for a few hours.

.....

.....

.....

.....

..... [2]

[Total: 10]

- 5 (a) Gibberellin is a plant growth regulator involved in barley seed germination. Production of gibberellin is stimulated by the uptake of water.

State the location of gibberellin synthesis in a barley seed during germination.

..... [1]

- (b) Barley seeds germinate when placed on blotting (absorbent) paper soaked in water.

The germination of barley seeds placed on blotting paper soaked in solutions of different water potential was investigated.

The success of germination was measured as a germination index for:

- barley seeds placed on blotting paper soaked in water
- barley seeds placed on blotting paper soaked in 5 solutions of different water potential.

The results are shown in Fig. 5.1.

The higher the germination index value, the more successful the germination of the barley seeds.

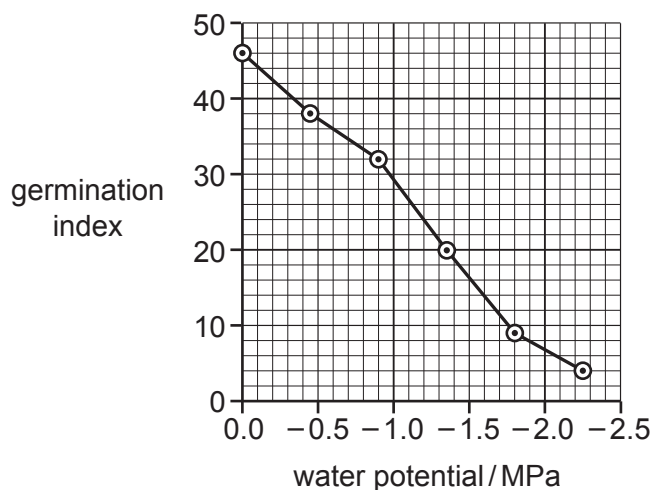


Fig. 5.1

- (i) With reference to Fig. 5.1, describe the relationship between the germination index of barley seeds and water potential.

.....

.....

.....

..... [2]

- (ii) Suggest explanations for the relationship shown in Fig. 5.1.

.....

.....

.....

.....

.....

..... [3]

- (c) During barley seed germination, gibberellin stimulates the synthesis of enzymes.

State the name of one of these enzymes **and** the precise location of its synthesis.

enzyme

location [2]

- (d) Some plants are grown commercially for their flowers. Many of these plants are varieties that have short stems.

Two factors that affect the height of stems are:

- gibberellin
- the *Le/le* gene.

The *Le/le* gene has two alleles, *Le* and *le*.

- (i) Suggest an advantage of growing a short-stemmed variety of a flowering plant.

.....

.....

..... [1]

- (ii) Explain how the *Le/le* gene and gibberellin are involved in affecting the height of plant stems.

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

3 During the germination of barley seeds, amylase is produced.

(a) Describe the sequence of events that lead to the production of amylase during germination of barley seeds.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (b) Malting is a process involved in the production of a drink called beer. During malting, barley seed germination is controlled so that the sugars produced during germination can be used in the production of beer.

Fig. 3.1 shows two features of a germinating barley seed during the first five days of malting:

- activity of the amylase enzyme
- the percentage of starch reserves remaining in the barley seed.

Key

- ×— starch reserves
—○— amylase activity

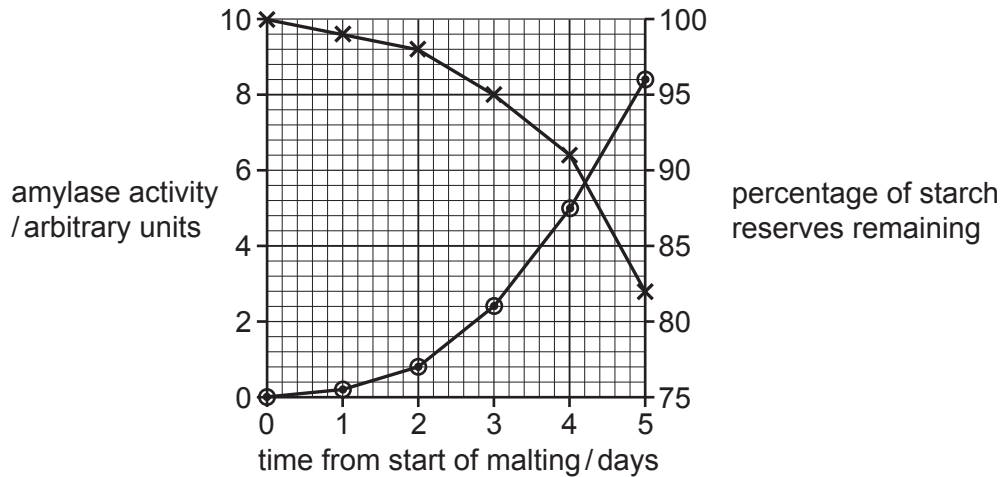


Fig. 3.1

- (i) State the precise location of the starch reserves in the barley seed.

..... [1]

- (ii) With reference to Fig. 3.1, describe **and** explain the effect of malting on amylase activity and the percentage of starch reserves remaining in the germinated barley seed.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (c) In the malting process, germination is stopped before the concentration of sugars in the germinating barley seeds exceeds a concentration that causes shoot or root growth.

Drying the germinating barley seeds at 50 °C is one method used to stop malting.

- (i) Explain how this method would stop malting.

.....

.....

.....

.....

.....

.....

..... [3]

- (ii) Suggest why malting is stopped before shoot or root growth occurs.

.....

.....

..... [1]

[Total: 12]

6(b) Pitcher plants are carnivorous plants that trap and digest insects in a large modified leaf called a pitcher.

Fig. 6.3 shows a pale pitcher plant, *Sarracenia alata*.

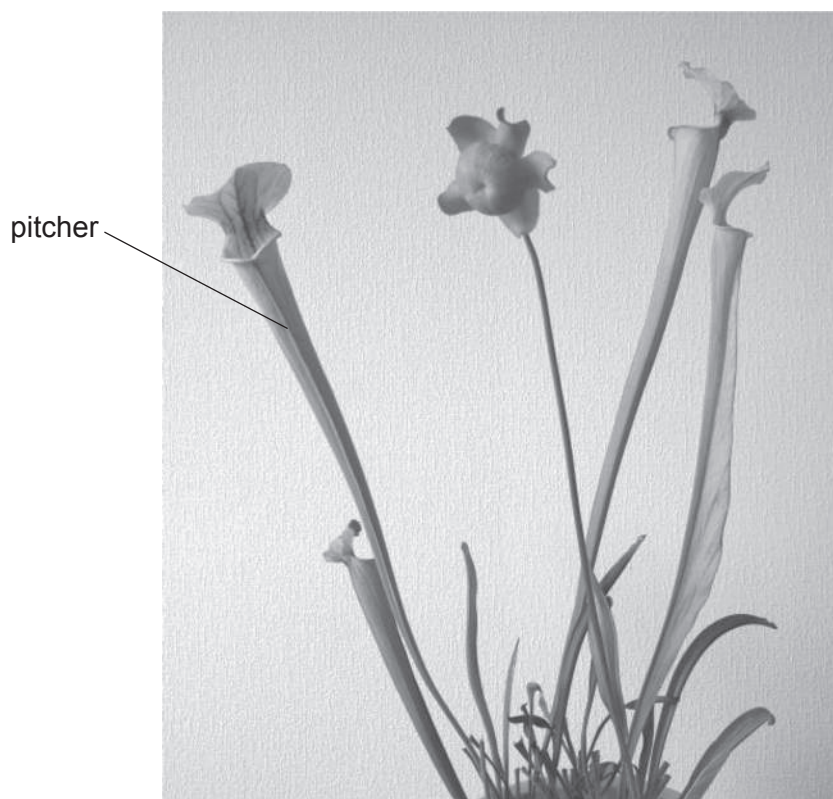


Fig. 6.3

- (i) Unlike the Venus fly trap, pitcher plants have no moving parts to trap insects. Insects are attracted to scent produced at the top of the pitcher. Once inside the pitcher, the insect slides down to the bottom and into a liquid containing digestive enzymes.

Suggest a type of enzyme found in the pitcher plant that is used to digest insects.

..... [1]

- (ii) Pitcher plants grow in bogs and wet grassland where the soil has a low concentration of minerals such as nitrates. The plants obtain nitrates from the digestion of insects.

Calvin cycle intermediates are used to synthesise more complex compounds, some of which need nitrogen from nitrates.

Name **one** compound that needs nitrogen from nitrates **and** name the Calvin cycle intermediate from which it is synthesised.

compound that needs nitrogen

Calvin cycle intermediate

[2]

[Total: 10]

- 1 (a) The golden mantella, *Mantella aurantiaca*, is a small terrestrial frog found in Madagascar.

Fig. 1.1 shows a golden mantella.



Fig. 1.1

- (b) The toxin in the skin of the golden mantella affects the action of the sarcomeres in muscle fibres (muscle cells) of mammalian striated muscle. The toxin inhibits a protein, $\text{Ca}^{2+}\text{ATPase}$, found in the membrane of the sarcoplasmic reticulum.

$\text{Ca}^{2+}\text{ATPase}$ pumps calcium ions from the cytoplasm into the sarcoplasmic reticulum when the fibre is no longer stimulated.

Suggest the consequences to the sarcomere of the action of the golden mantella toxin.

.....

.....

.....

.....

.....

.....

..... [3]

(c) Describe the role of calcium ions in a cholinergic synapse.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

- 10 (a) Motor neurones and sensory neurones have different roles in nervous coordination.

Contrast the structure **and** function of sensory neurones and motor neurones.

.....

.....

.....

.....

.....

..... [3]

- (b) Mammals have many types of neurones, which vary in axon diameter and myelination.

Table 10.1 shows the axon diameter and mean impulse transmission speed of four different types of mammalian neurone.

Table 10.1

neurone type	myelination	mean axon diameter / μm	mean impulse transmission speed/ ms^{-1}
motor α	✓	13.0–20.0	80–120
motor β	✓	6.0–12.0	35–75
motor δ	✓	1.0–5.0	5–35
motor C	x	0.2–1.5	0.5–2.0

Using the data shown in Table 10.1, comment on the relationship between:

- myelination and mean impulse transmission speed
- axon diameter and mean impulse transmission speed.

.....

.....

.....

.....

.....

..... [3]

(c) Fig. 10.1 is a graph of an action potential in a mammalian neurone.

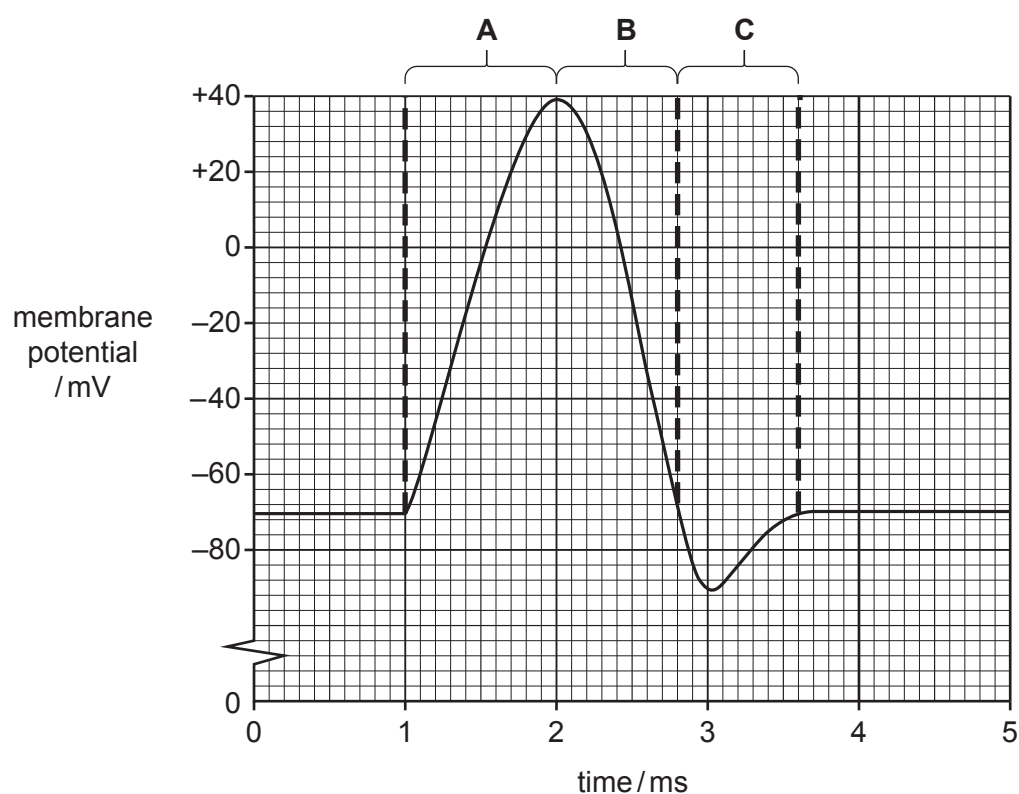


Fig. 10.1

With reference to Fig. 10.1 suggest why:

- no further action potential can occur during **A** and **B**
- it is difficult for a further action potential to occur during **C**.

.....

.....

.....

.....

.....

..... [3]

[Total: 9]

- 6 (a) Gibberellin is a plant hormone that has an important role in seed germination.

Fig. 6.1 is a diagram of a section through a barley seed (grain).

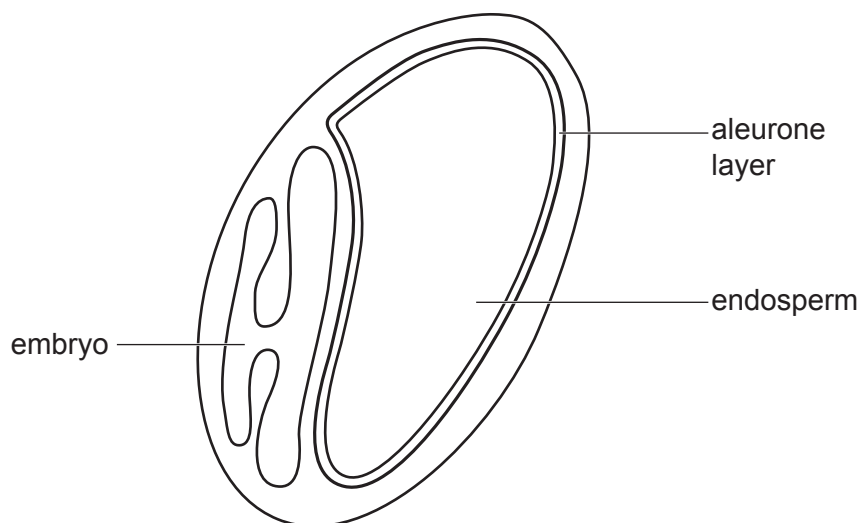


Fig. 6.1

On Fig. 6.1:

- Draw **one** arrow, labelled **G**, to show the movement of gibberellin during germination.
- Draw **one** arrow, labelled **A**, to show the movement of amylase during germination.

[2]

- (b) Outline the role of amylase in seed germination.

.....

.....

.....

.....

.....

.....

.....

.....

.....

[3]

(c) The germination of three groups of seeds of the plant *Penstemon digitalis* was investigated.

The seeds were soaked for 24 hours in distilled water or in a solution of gibberellin. They were then sown on filter paper in dishes and kept moist for 10 days.

Fig. 6.2 shows the results for each group.

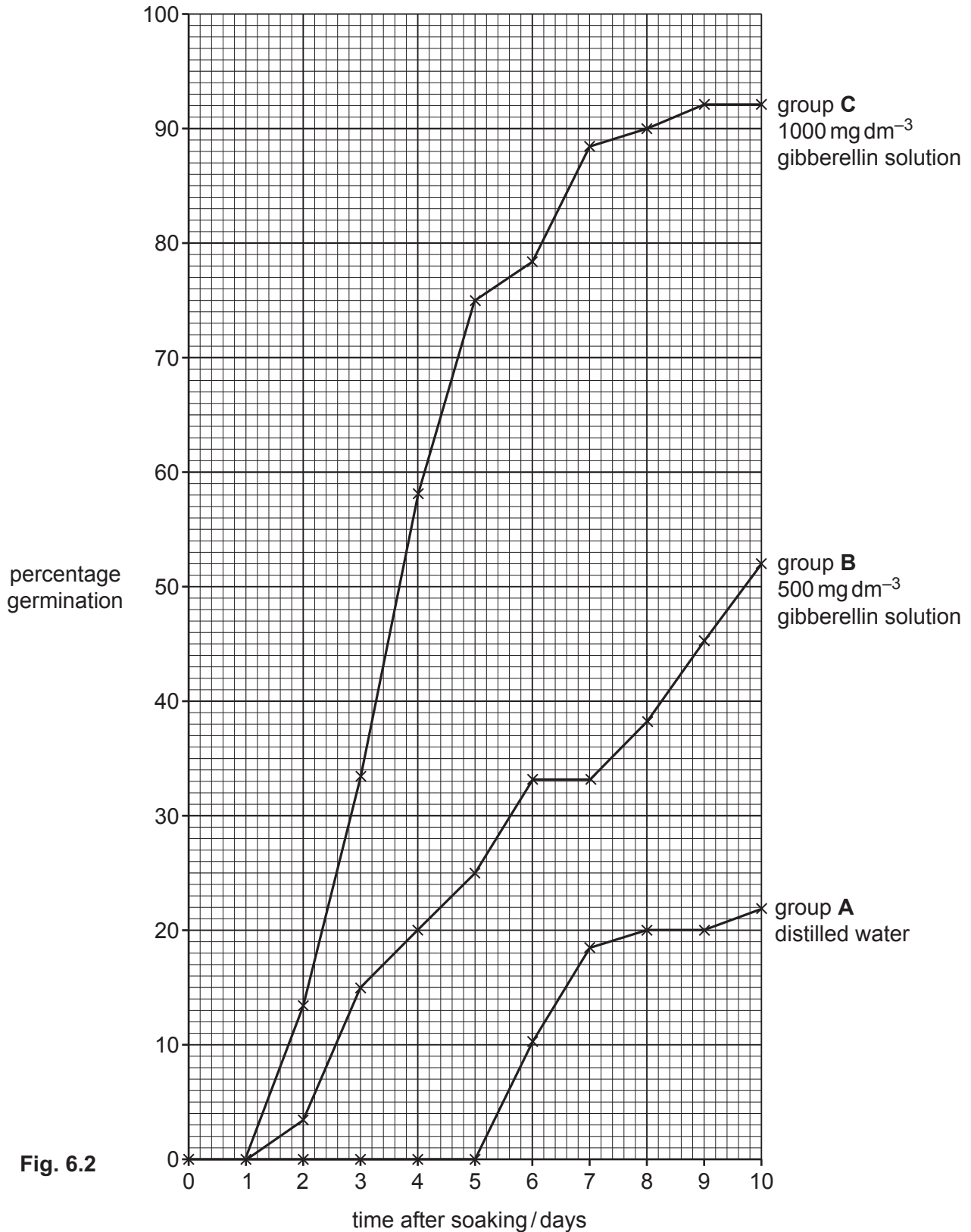


Fig. 6.2

Describe the results shown in Fig. 6.2.

[4]

[Total: 9]

- 8 The role of sensory receptor cells in mammals is to detect stimuli and generate action potentials in sensory neurones.

Human taste buds on the tongue contain chemoreceptor cells. Different chemoreceptor cells respond to different chemical stimuli.

Fig. 8.1 is a diagram of chemoreceptor cells in a taste bud.

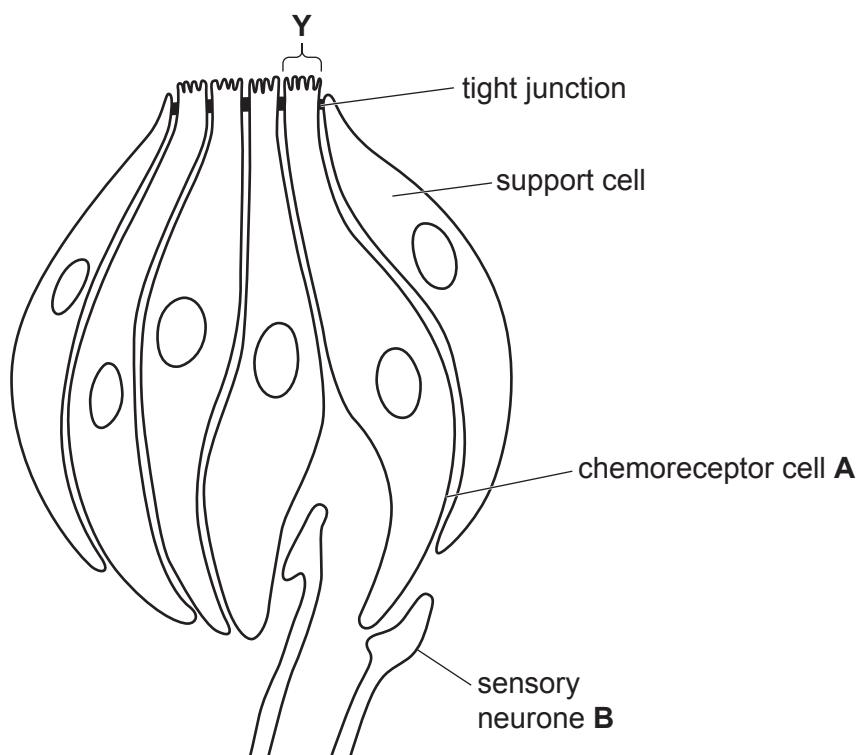


Fig. 8.1

- (a) Name the structures in the region Y.

..... [1]

- (b) Suggest a reason for the tight junctions between the chemoreceptor cells.

.....

 [1]

- (c)** Chemoreceptor cell **A** responds to sodium ions (Na^+) in salt.

Describe how the contact of cell **A** with Na^+ can result in an action potential in sensory neurone **B**.

..... [7]

[Total: 9]

Biology 9700-Paper 4 Year 2022 (M/J) Variant 3

- 6 The role of sensory receptor cells in mammals is to detect stimuli and generate action potentials in sensory neurones.

Human taste buds on the tongue contain chemoreceptor cells. Different chemoreceptor cells respond to different chemical stimuli.

Fig. 6.1 is a diagram of chemoreceptor cells in a taste bud.

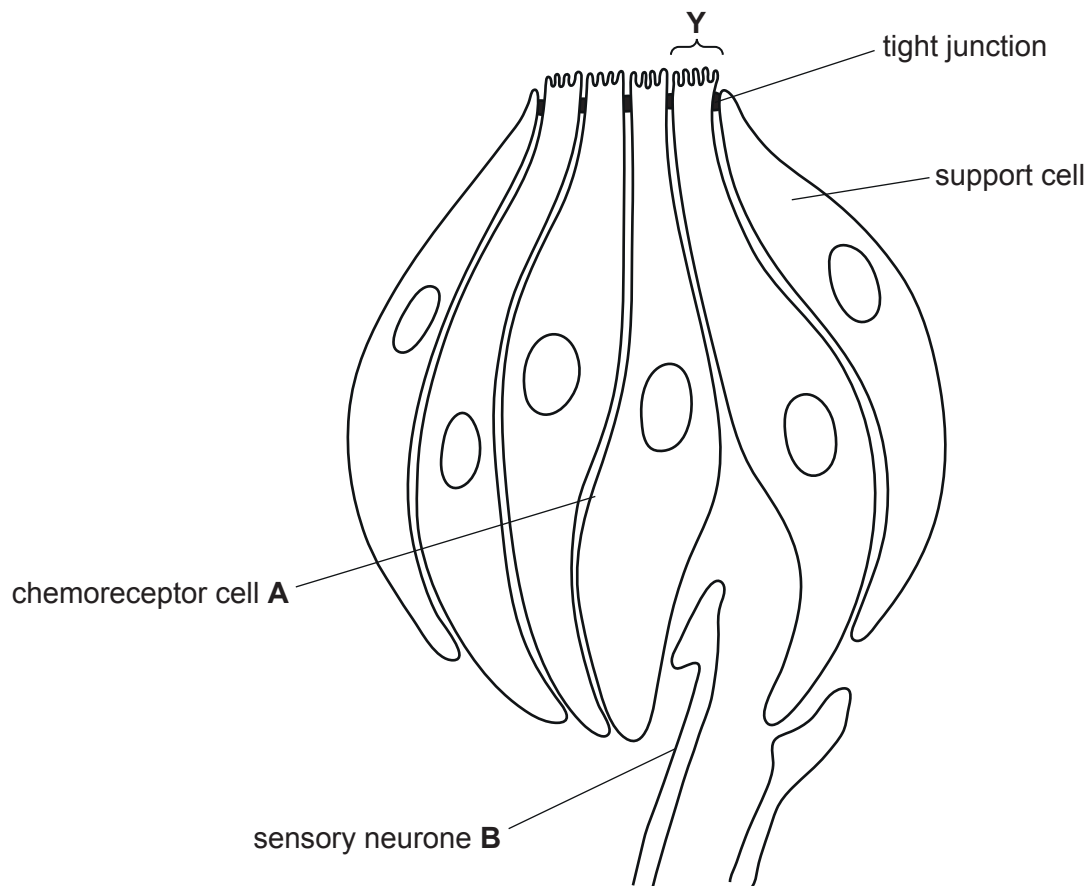


Fig. 6.1

- (a) Name the structures in the region **Y** and describe their function in a chemoreceptor cell.

.....

.....

.....

.....

.....

..... [3]

- (b)** When a sugar molecule binds to a receptor protein on the cell surface membrane of cell **A**, calcium ions are released into the cytoplasm of the cell by the endoplasmic reticulum.

Explain how the release of calcium ions will lead to an action potential being generated in sensory neurone **B**.

[6]

[Total: 9]

- 9 (a) Fig. 9.1 shows a cross-section through a myelinated neurone.

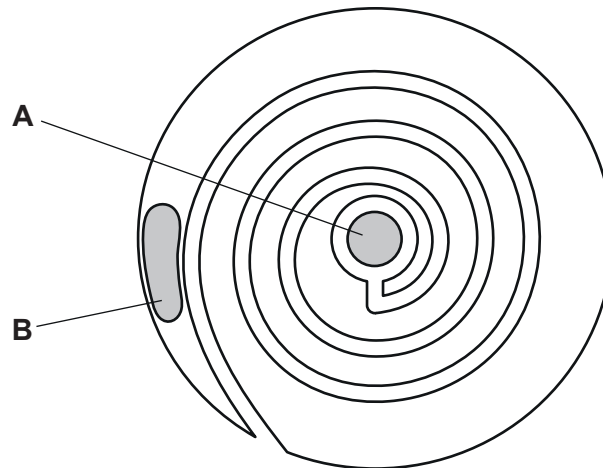


Fig. 9.1

Identify structures **A** and **B**.

A

B [2]

- (b) With reference to voltage-gated sodium ion channels, explain the difference in speed of transmission of an action potential along a myelinated neurone and a non-myelinated neurone.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 6]

Biology 9700-Paper 4 Year 2022 (O/N) Variant 1 & 3

- 9 (a) A neuromuscular junction allows the transmission of an action potential from a motor neurone to a striated muscle fibre, causing it to contract.

Fig. 9.1 is a graph of an action potential in a motor neurone.

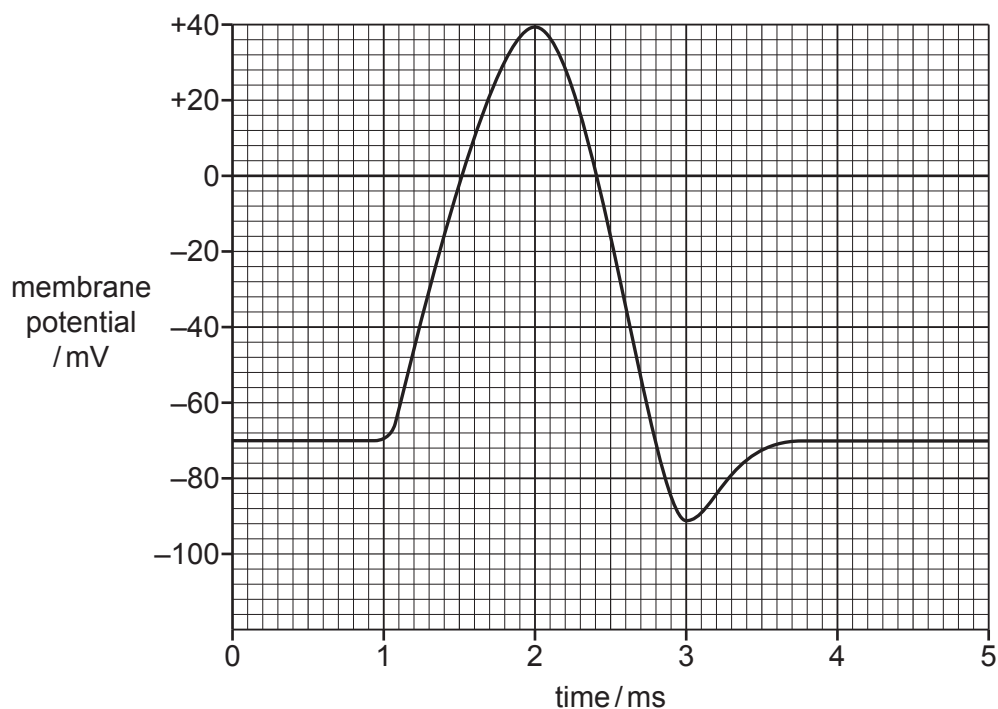


Fig. 9.1

Fig. 9.2 is a graph of an action potential in a striated muscle fibre.

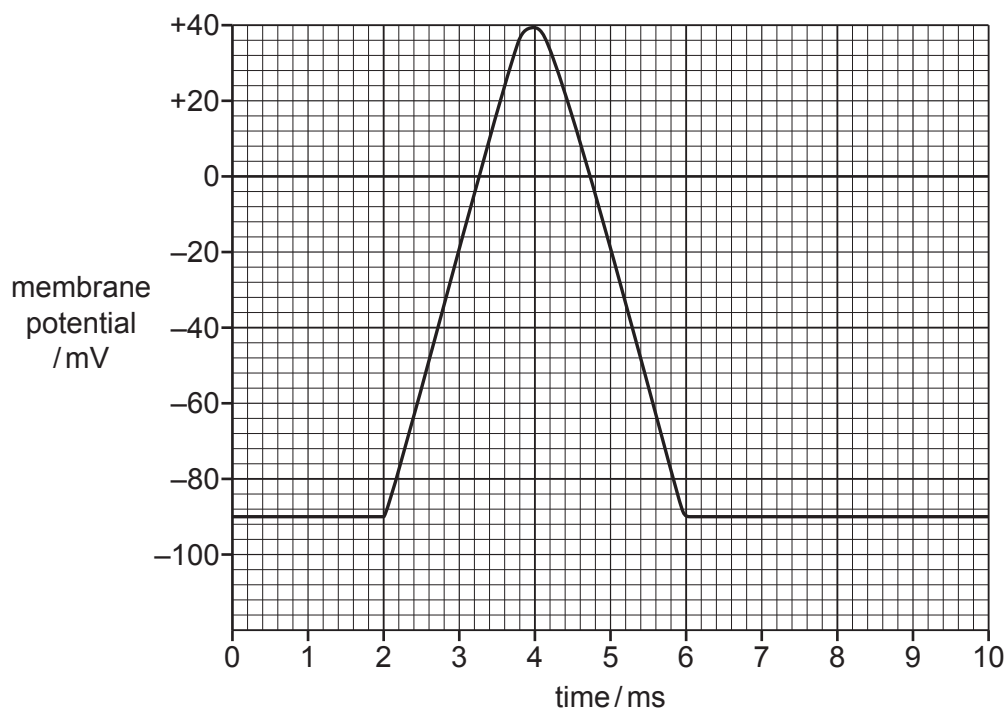


Fig. 9.2

With reference to Fig. 9.1 and Fig. 9.2, describe the differences between the action potential in a motor neurone and the action potential in a striated muscle fibre.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b) There are three phases in the contraction of a striated muscle: latent phase, contraction phase and relaxation phase.

The tension in a muscle represents the degree of contraction of its fibres.

Fig. 9.3 is a graph of the tension in a striated muscle during the three phases of contraction.

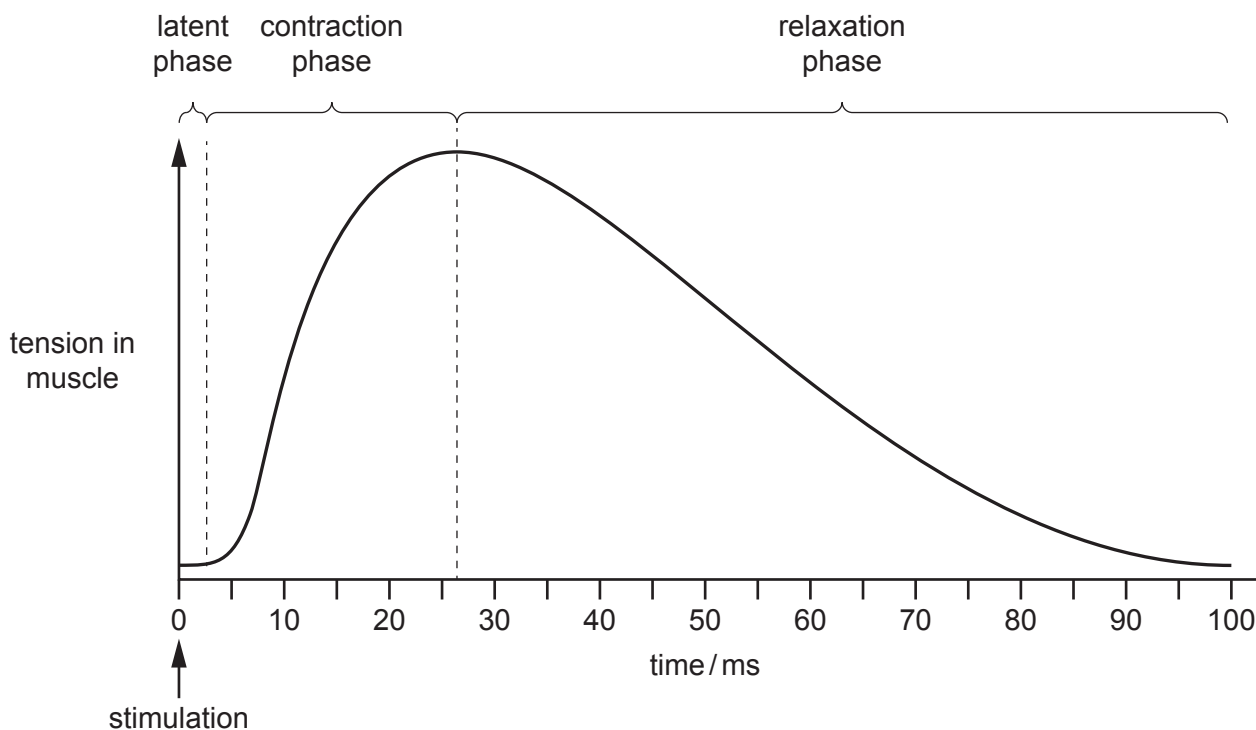


Fig. 9.3

- (i) With reference to Fig. 9.3, explain what is happening in the striated muscle fibre during the latent phase.

.....

.....

.....

.....

.....

..... [3]

- (ii) Suggest why the relaxation phase shows a gradual decrease in muscle tension.

.....

.....

..... [1]

[Total: 8]

Biology 9700-Paper 4 Year 2022 (O/N) Variant 2

- 9 (a) Voltage-gated channels are involved in the generation of an action potential.

Fig. 9.1 is a diagram of the voltage-gated channels of sodium ions and potassium ions in the membrane of an axon. The channels are shown in three different states, 1, 2 and 3.

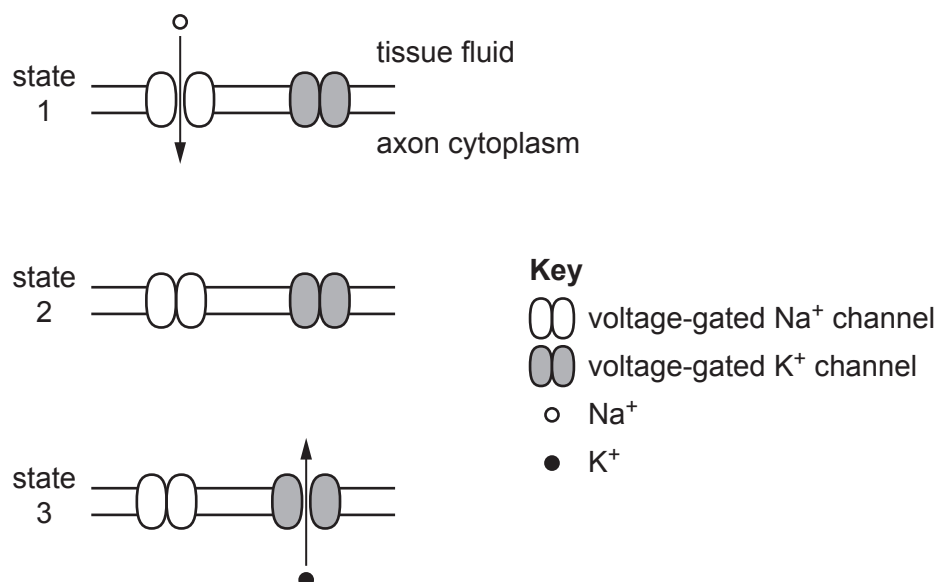


Fig. 9.1

Fig. 9.2 is a diagram of different phases of an action potential in an axon. The phases are labelled A, B, C, D, E, F and G.

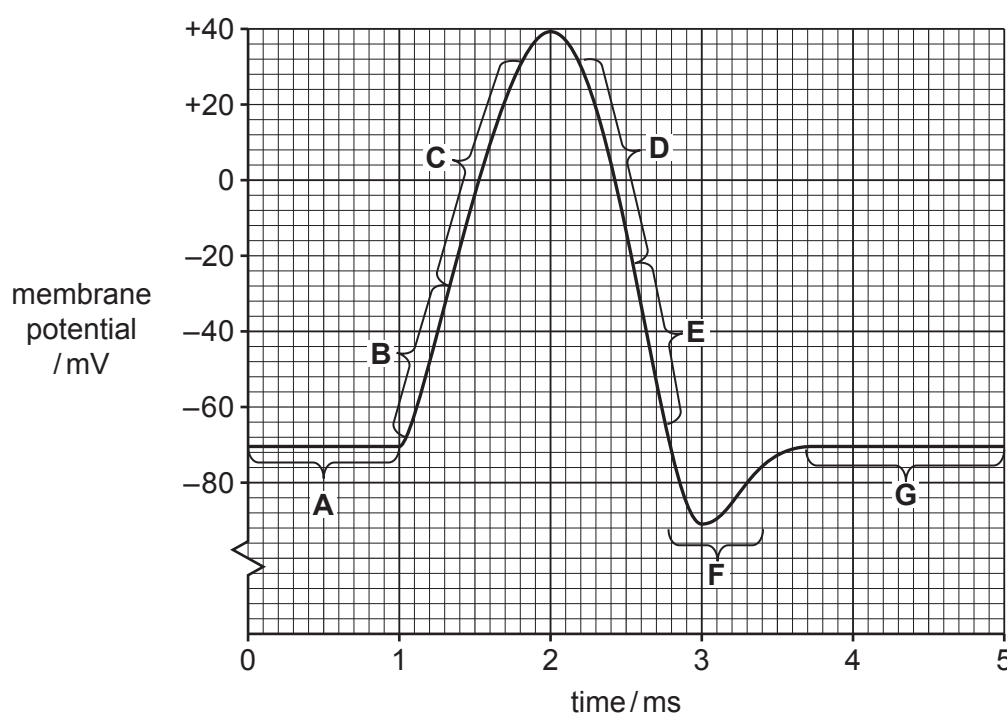


Fig. 9.2

Complete Table 9.1 to match each of the listed phases of the action potential with the appropriate state of the voltage-gated channels: **1**, **2** or **3**.

Table 9.1

phase of action potential	state of voltage-gated channels
A	
C	
E	
F	
G	

[3]

(b) Many neurones are surrounded by myelin sheaths.

Describe **and** explain the role of the myelin sheath in the transmission of an action potential.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 6]

Biology 9700-Paper 4 Year 2023 (March)

- 7 (a) Fig. 7.1 is a diagram representing a synapse between a chemoreceptor cell from a human taste bud and a dendrite of a sensory neurone.

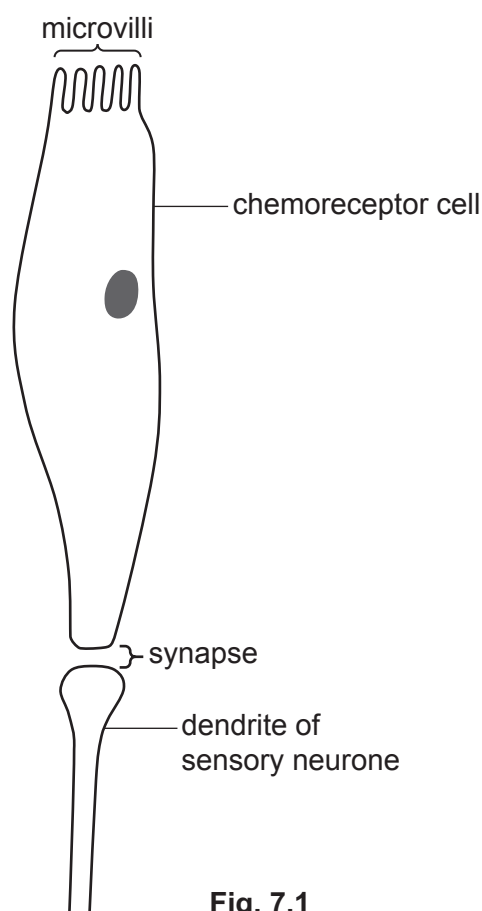


Fig. 7.1

In an experiment, different concentrations of sodium chloride solution were applied to the microvilli of the chemoreceptor cell. The membrane potential of the chemoreceptor cell and the membrane potential of the dendrite of the sensory neurone were recorded for each concentration.

The resting potential of this chemoreceptor cell is -50 mV and the resting potential of the dendrite of this sensory neurone is -70 mV .

The results are shown in Table 7.1.

Table 7.1

concentration of sodium chloride solution / g dm^{-3}	membrane potential / mV	
	chemoreceptor cell	dendrite of sensory neurone
0.1	-50	-70
1.0	$+30$	$+40$
10.0	$+30$	$+40$

Explain the results shown in Table 7.1.

[4]

(b) Describe the differences in structure **and** function between sensory neurones and motor neurones.

[3]

[Total: 7]

9 (a) Fig. 9.1 is a diagram of a relaxed sarcomere in striated muscle.

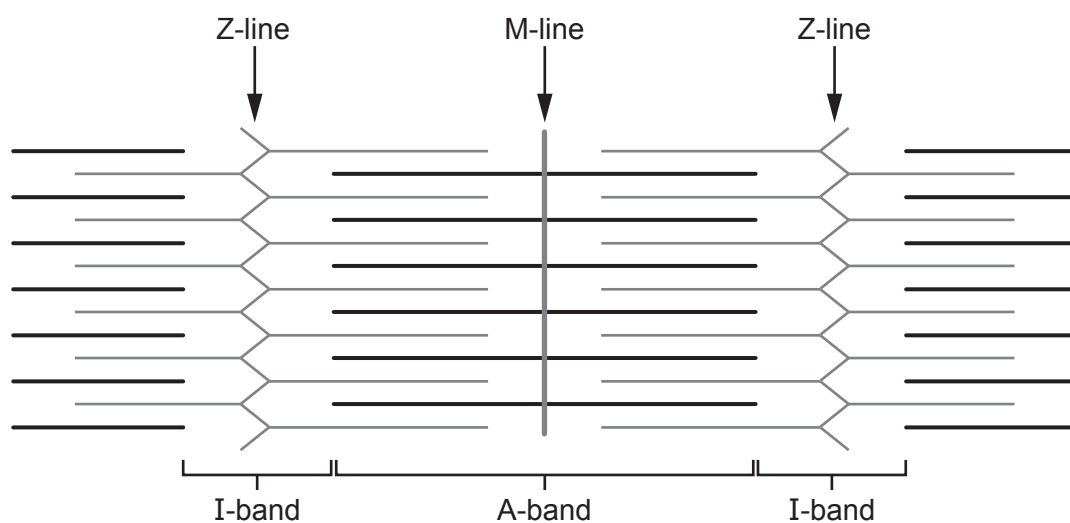


Fig. 9.1

- (i) On Fig. 9.1, use label lines and letters to label:
- an actin filament with the letter **P**
 - a myosin filament with the letter **R**.

[2]

- (ii) State what happens to the A-band and the I-band when the sarcomere contracts.

A-band

I-band

[2]

- (b)** The plant *Strychnos toxifera* produces the toxin curare, which can cause muscle paralysis in mammals.

The toxin acts by binding to receptors on the cell surface membranes (sarcolemma) of muscle cells at neuromuscular junctions.

- (i) Suggest how binding of curare to receptors may cause muscle paralysis.

..... [4]

[4]

- (ii) Suggest why the action of curare may lead to the death of a mammal.

.....

.....

.....

.....

..... [2]

[Total: 10]

Biology 9700-Paper 4 Year 2023 (M/J) Variant 1

- 7 Amino acids are the monomers that are used to produce proteins in organisms. Amino acids also have other, non-protein, roles in the body.

- (a) Fig. 7.1 shows the structures of five amino acids with varying numbers and arrangements of carbon atoms.

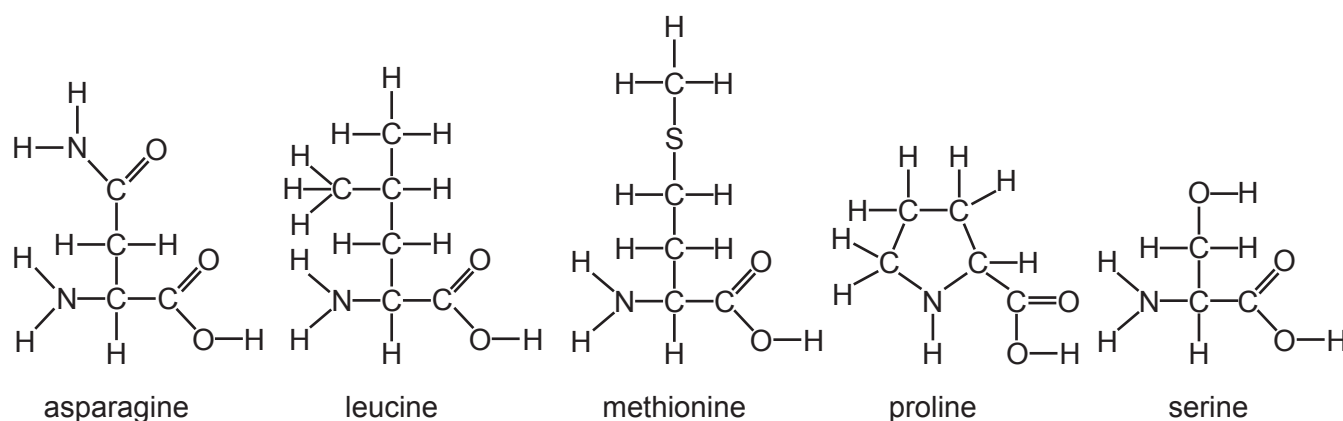


Fig. 7.1

In the liver, one of these amino acids can be converted to pyruvate and one of these amino acids can be converted to oxaloacetate.

Suggest which of the amino acids shown in Fig. 7.1 would be most directly converted to:

- pyruvate
- oxaloacetate.

amino acid converted to pyruvate **TOPIC 14**

amino acid converted to oxaloacetate **TOPIC 14**

[2]

- (b) The amino acid glycine can act as a neurotransmitter.

A glycinergic synapse is shown in Fig. 7.2.

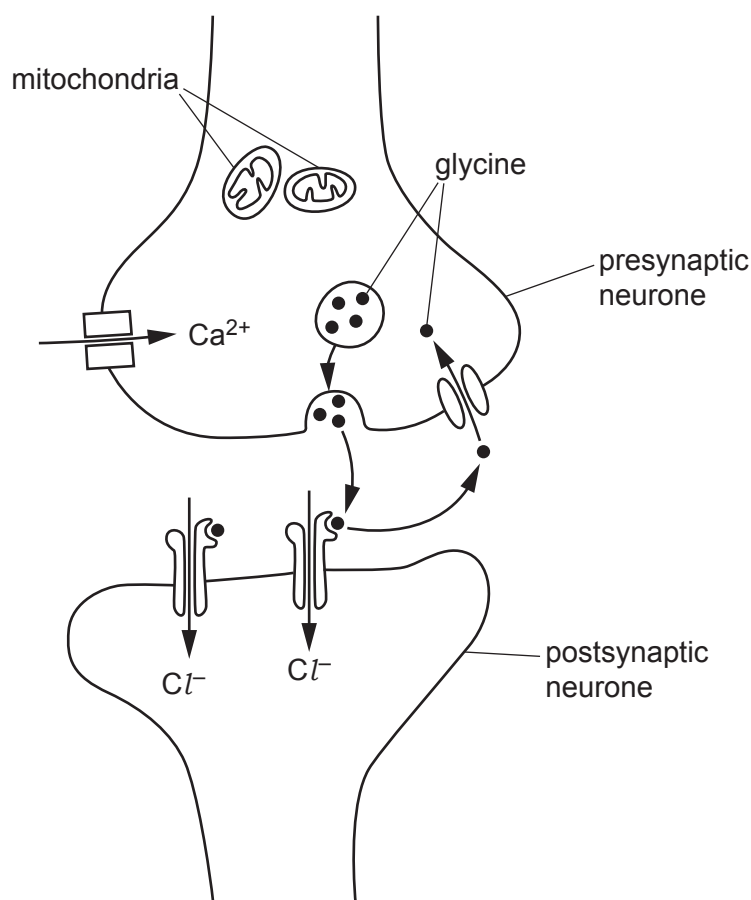


Fig. 7.2

- (i) The glycinergic synapse and a cholinergic synapse use different neurotransmitters and different postsynaptic receptors.

Describe differences between the glycinergic synapse shown in Fig. 7.2 and a cholinergic synapse.

.....

.....

.....

.....

.....

..... [2]

- (ii) The binding of glycine to receptors, as shown in Fig. 7.2, makes an action potential less likely to occur in the postsynaptic neurone.

Suggest why an action potential is less likely to occur after the binding of glycine to receptors.

.....

.....

.....

.....

..... [2]

- (iii) Neurones need to maintain a resting potential before an action potential can occur.

Describe how a neurone maintains a resting potential.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

Biology 9700-Paper 4 Year 2023 (M/J) Variant 2

- 7 (a) A striated muscle cell (muscle fibre) will contract when stimulated by a motor neurone at a neuromuscular junction.

Air temperature can affect the temperature of striated muscle cells.

Investigations have shown that the efficiency of contraction of striated muscle cells decreases when the air temperature decreases.

Suggest reasons why a reduction in temperature can decrease the efficiency of contraction of striated muscle cells.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b) The greater blue-ringed octopus, *Hapalochlaena lunulata*, produces tetrodotoxin (TTX). TTX is a neurotoxin. If a mammal is bitten by this octopus, the effect of TTX can cause the death of the mammal.

Fig. 7.1 shows a greater blue-ringed octopus.

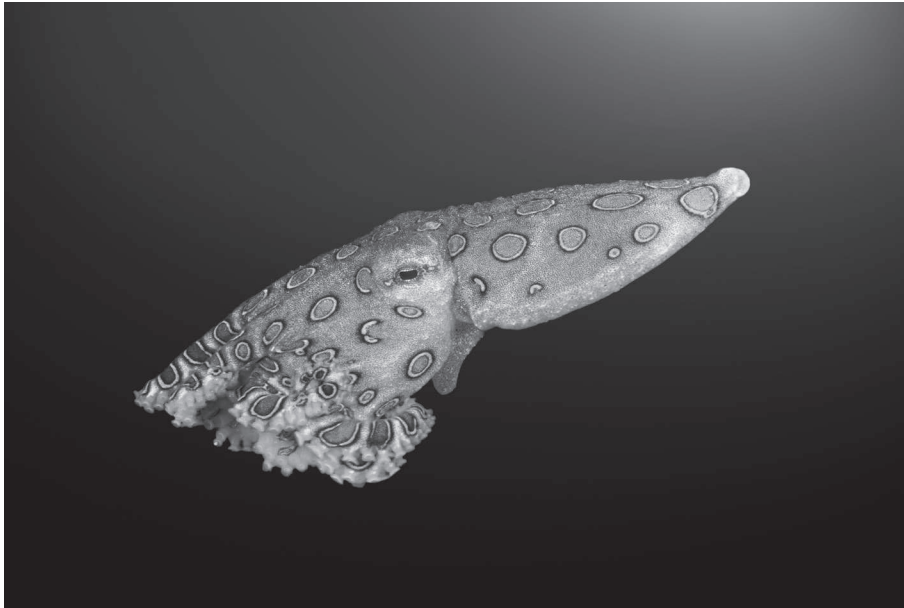


Fig. 7.1

TTX binds to voltage-gated sodium ion channels in the axon of a neurone and changes the tertiary structure of the channel protein.

Suggest how TTX may affect the functioning of a motor neurone.

.....

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 7]

Biology 9700-Paper 4 Year 2023 (M/J) Variant 3

- 7 (a) Sarcomeres are the functioning units of the myofibrils of the muscle fibres (muscle cells) of striated muscle.

The arrival of an action potential at the sarcoplasmic reticulum of a striated muscle fibre can lead to the shortening of a sarcomere. This shortening occurs by the sliding filament model.

Outline the sequence of events occurring after stimulation of the sarcoplasmic reticulum that results in the shortening of a sarcomere.

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b) Scientists compared the diameter of samples of striated muscle fibres taken from young mice and adult mice.

The results are shown in Fig. 7.1.

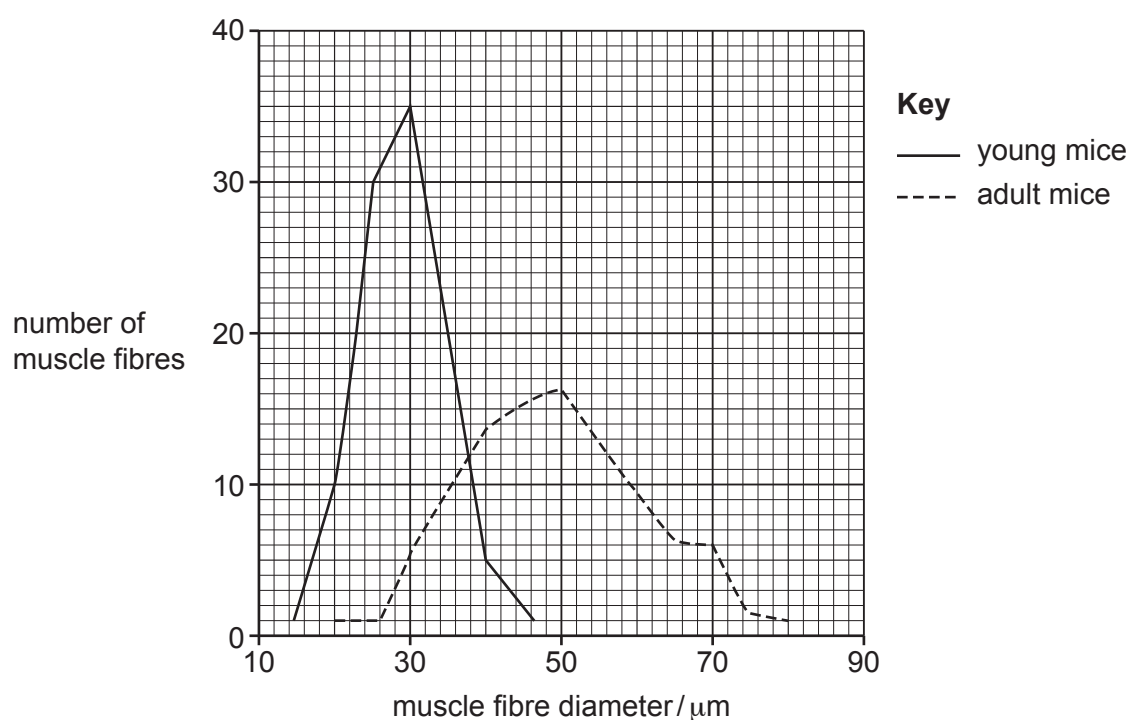


Fig. 7.1

With reference to Fig. 7.1:

- describe **two** differences between the muscle fibres of young mice and adult mice
- suggest how these differences may affect the sliding filament model.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 8]

- 9 (a)** Dopamine is a neurotransmitter released in some synapses in the brain. The release and action of dopamine is similar to that of acetylcholine.

Fig. 9.1 is a diagram of a brain synapse where dopamine is the neurotransmitter.

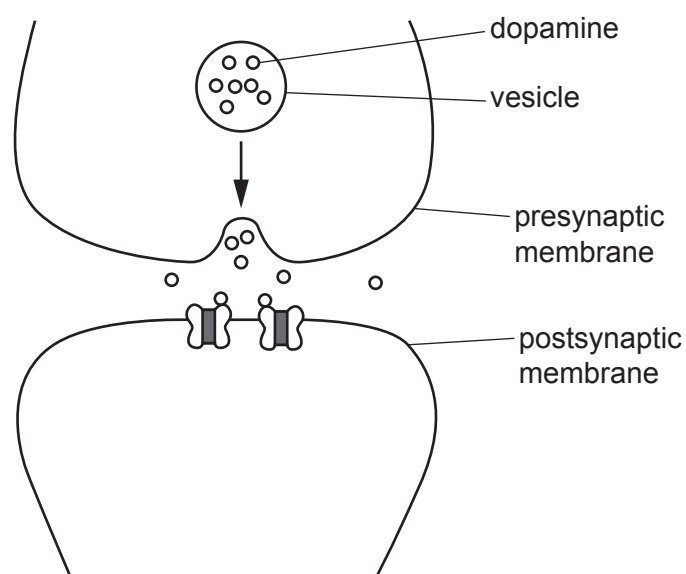


Fig. 9.1

- (i) Describe how the release of dopamine from the presynaptic neurone can lead to an action potential in the postsynaptic neurone.

[4]

- (ii) In brain cells, the amino acid tyrosine is changed into DOPA, which then is converted to dopamine.

Name another compound in the body produced from DOPA.

..... [1]

- (b) In some brain synapses, the neurotransmitter gamma-aminobutyric acid (GABA) is released. This results in an influx of chloride ions into the postsynaptic neurone.

Suggest **and** explain whether an action potential would be generated in the postsynaptic neurone if GABA is released into a brain synapse.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

Biology 9700-Paper 4 Year 2023 (O/N) Variant 1 & 3

3.(d) Scientists are researching whether abscisic acid can be used in crop treatment to increase yield. Evidence suggests that abscisic acid modifies the effect of auxin on elongation growth in plants.

(i) Scientists investigated the effect of different concentrations of abscisic acid on root elongation in seedlings of thale cress, *Arabidopsis thaliana*.

The seedlings were divided into four groups:

- a control group (0.0 μmol abscisic acid)
- three experimental groups, each treated with a different concentration of abscisic acid: 0.1 μmol , 1.0 μmol , or 10.0 μmol .

For each group of seedlings, root length was measured for six days during treatment. The rate of root elongation was calculated each day.

The results are shown in Fig. 3.3.

Key

- control (no abscisic acid)
- ⊙ 0.1 μmol of abscisic acid
- × 1.0 μmol of abscisic acid
- △ 10.0 μmol of abscisic acid

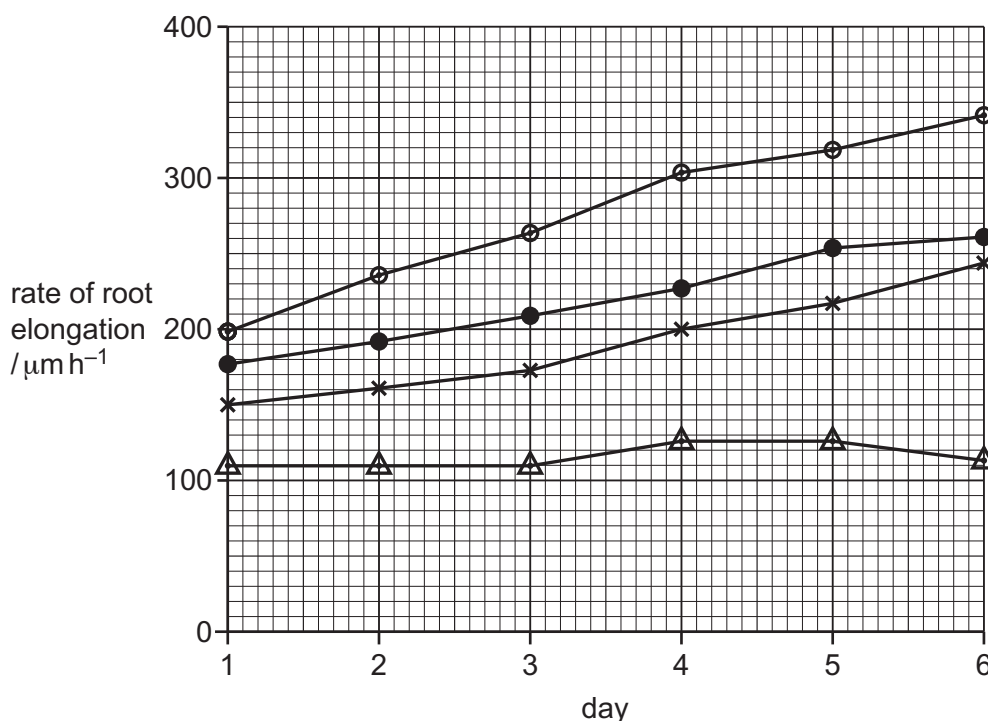


Fig. 3.3

With reference to Fig. 3.3, describe the effect of treatment with abscisic acid on the rate of root elongation.

.....

.....

.....

.....

.....

.....

..... [3]

- (ii) The passage outlines the role of auxin in elongation growth in plants.

Complete the passage by using the most appropriate scientific terms.

The binding of auxin to receptors causes to be pumped into cell walls.

This activates proteins called expansins, which disrupt the links between

..... microfibrils. The cell walls are then able to expand.

[2]

[Total: 16]

- 7 When an impulse arrives at a neuromuscular junction, it stimulates a muscle fibre of striated muscle to contract.

- (a) (i) Outline the **similarities** in structure between a neuromuscular junction and a cholinergic synapse.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (ii) The hydrolysis of ATP during muscle contraction releases inorganic phosphate (P_i).

Calcium ions (Ca^{2+}) can combine with P_i in the sarcoplasmic reticulum to form insoluble calcium phosphate. This may result in fewer power strokes occurring in sarcomeres.

Suggest why calcium phosphate formation in the sarcoplasmic reticulum may result in fewer power strokes occurring in sarcomeres.

.....

.....

.....

.....

.....

.....

..... [3]

- (b) Adrenaline is a hormone that can affect muscle contraction. Adrenaline binds to G-protein-coupled receptors on T-tubule membranes.

The cell signalling pathway that occurs in response to the binding of adrenaline is similar to the pathway that occurs in liver cells in response to the binding of glucagon.

Fig. 7.1 is an outline of the cell signalling pathway of adrenaline.

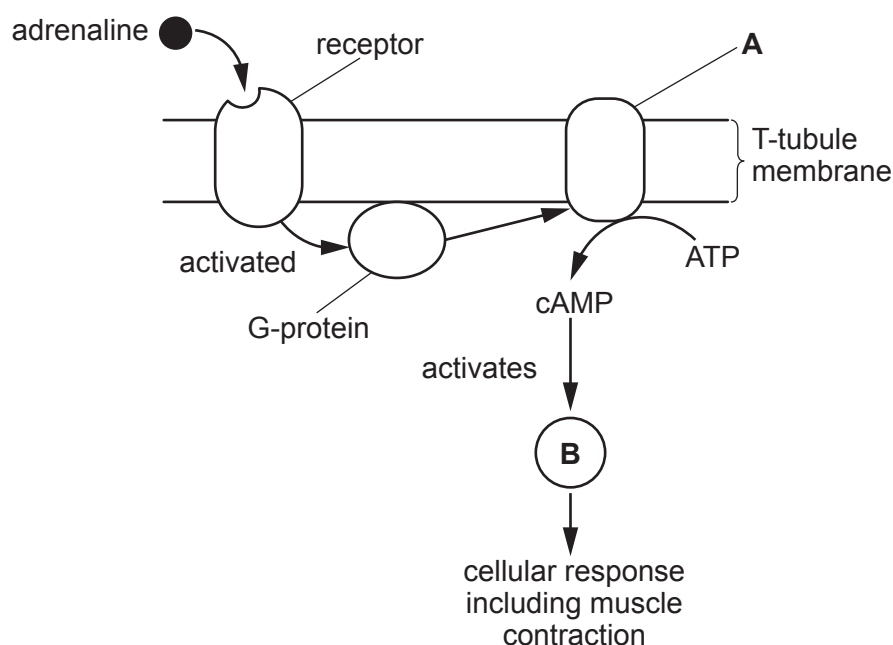


Fig. 7.1

Identify the molecules represented by **A** and **B** in Fig. 7.1.

A

B

[2]

[Total: 9]

- (ii) When high frequency sound is detected, the receptor cells in the tympanal organ stimulate the transmission of impulses in sensory neurones.

Describe the sequence of events that results in an action potential in a sensory neurone.

The first event in the sequence has been given for you.

Calcium ions enter the cytoplasm of the receptor cell

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

Biology 9700-Paper 4 Year 2023 (O/N) Variant 2

- 7 (a) There are many mitochondria located in the presynaptic knobs of neuromuscular junctions and in the sarcomeres of muscle fibres of striated muscle.

Explain the need for many mitochondria in the presynaptic knobs and in the sarcomeres.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b) Fig. 7.1 is a diagram of synapses between a postsynaptic neurone and two presynaptic neurones, **X** and **Y**.

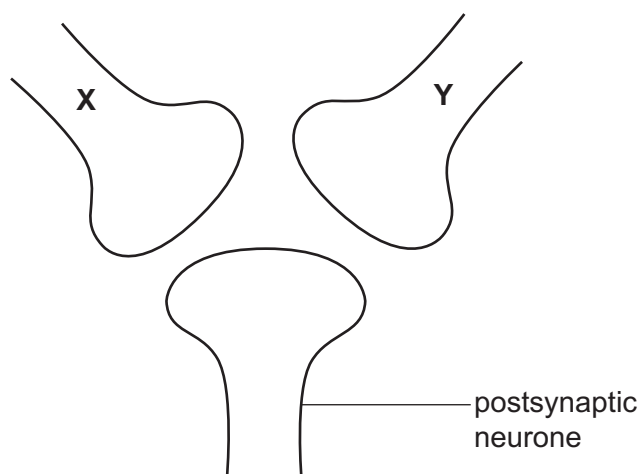


Fig. 7.1

- Neurone **X** releases the neurotransmitter acetylcholine.
- Neurone **Y** releases the neurotransmitter glutamate.
- Both neurotransmitters bind to channel proteins in the membrane of the postsynaptic neurone.
- Acetylcholine binding results in an influx (entry) of sodium ions.
- Glutamate binding results in an influx of chloride ions.

A student made three statements:

1. When only neurone **X** is stimulated, an action potential **will** occur in the postsynaptic neurone.
2. When only neurone **Y** is stimulated, an action potential **will** occur in the postsynaptic neurone.
3. When neurone **X** and neurone **Y** are stimulated at the same time, an action potential **will not** occur in the postsynaptic neurone.

Explain whether or not you agree with these statements.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (c) Multiple sclerosis is a condition in which the myelin sheath breaks down in some neurones.

Suggest the effect of multiple sclerosis on the transmission of action potentials in the affected neurones.

.....

.....

.....

.....

..... [2]

[Total: 9]

- 9.(b) Outline the differences between the endocrine system and the nervous system.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

Biology 9700-Paper 4 Year 2024 (March)

2.(b) The scientists P W Brian and H G Hemming identified that the difference in the length of the stem in pea plants was associated with the presence or absence of gibberellin. They published their findings in 1955.

- (i) Gibberellin leads to a response in plant cells by binding to specific receptor molecules.

State the term used to describe a molecule, such as gibberellin, that binds to specific receptor molecules and leads to a response in cells.

..... [1]

- (ii) Suggest the response of the cells in the internode region of the stem, as labelled in Fig. 2.1, to the presence of gibberellin **and** describe how this response affects the trait investigated by Mendel.

.....

 [2]

[Total: 7]

- 9 (a) An investigation was carried out to study the effect of different intensities of blue light on the percentage germination of barley seeds. Barley seeds were exposed to blue light for a period of seven days. All other variables were kept constant.

The results are shown in Table 9.1.

Table 9.1

light intensity /arbitrary units (au)	percentage germination
0 (dark)	98.0
36	76.9
48	45.0
57	14.7

The effect of blue light on the concentration of abscisic acid (ABA) was also investigated. ABA concentration was measured at intervals over seven days in barley seeds exposed to blue light at an intensity of 57 arbitrary units.

The results are shown in Table 9.2.

Table 9.2

day	concentration of ABA /arbitrary units (au)
0	100
1	90
3	350
5	351
7	381

For comparison, in the dark the concentration of ABA in barley seeds fell from 100 au at the start (day 0) to 45 au on day 1 and did **not** increase from day 1 to day 7.

ABA is thought to affect gibberellin synthesis or activity.

Using the information in Table 9.1 and Table 9.2, describe the effect of blue light on the germination of barley seeds **and** suggest an explanation for this effect.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) After germination, auxin is important in the growth of barley plants.

Describe **and** explain the role of auxin in cell elongation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

[Total: 11]

- 10 (a)** Striated muscle is composed of myofibrils. Myofibrils contain several structural proteins including troponin, tropomyosin, actin and myosin.

Outline the roles of these four structural proteins in the contraction of a sarcomere.

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (b)** Drugs that cause muscle paralysis (paralytic drugs) are used during surgery to stop the patient moving. One commonly used paralytic drug is succinylcholine, which works by preventing contraction of muscles. Succinylcholine is able to prevent muscles contracting because it has a similar shape to acetylcholine.

Suggest how succinylcholine is able to prevent muscles contracting.

.....

.....

.....

.....

.....

.....

..... [3]

Biology 9700-Paper 4 Year 2024 (M/J) Variant 1

- 2 (a) Coordination in humans involves two main systems: the nervous system and the endocrine system. Paracrine cell signalling is a third way in which coordination occurs. In paracrine signalling, one cell secretes a chemical that diffuses a short distance to act upon cells that are very near to the secreting cell.

- (i) Identify **one** similarity and **one** difference between paracrine cell signalling and cell signalling that occurs as part of the endocrine system. **LINKS WITH TOPIC 14**

.....

.....

.....

..... [2]

- (ii) Explain why a neurotransmitter such as acetylcholine could be described as a paracrine signalling molecule.

.....

.....

.....

..... [2]

- (b) Human muscle cells show paracrine signalling. After muscle cells have been exposed to a substance called palmitate they:

- produce a signalling molecule
- show an increase in the expression of genes involved in a stress response (stress genes).

Scientists carried out three experiments to investigate the signalling molecule produced by muscle cells after they have been exposed to palmitate.

Experiment A

- Muscle cells were exposed to palmitate.
- The palmitate-exposed muscle cells were removed from the medium containing palmitate and then cultured in a nutrient medium for six days.
- The palmitate-exposed cells were removed from the nutrient medium and **new** muscle cells were placed in this used nutrient medium.
- The expression of stress genes in the **new** muscle cells was measured after 24 hours.
- A **control** using cells that had **not** been exposed to palmitate was also carried out.

Experiment B

Experiment **A** was repeated but the used nutrient medium for the palmitate-exposed cells and the control was boiled and then cooled before adding the new muscle cells.

Experiment C

Experiment **A** was repeated but the used nutrient medium from the palmitate-exposed cells and the control was treated to separate the lipid part. This lipid part was added to a new nutrient medium to culture the new muscle cells.

The results are shown in Fig. 2.1.

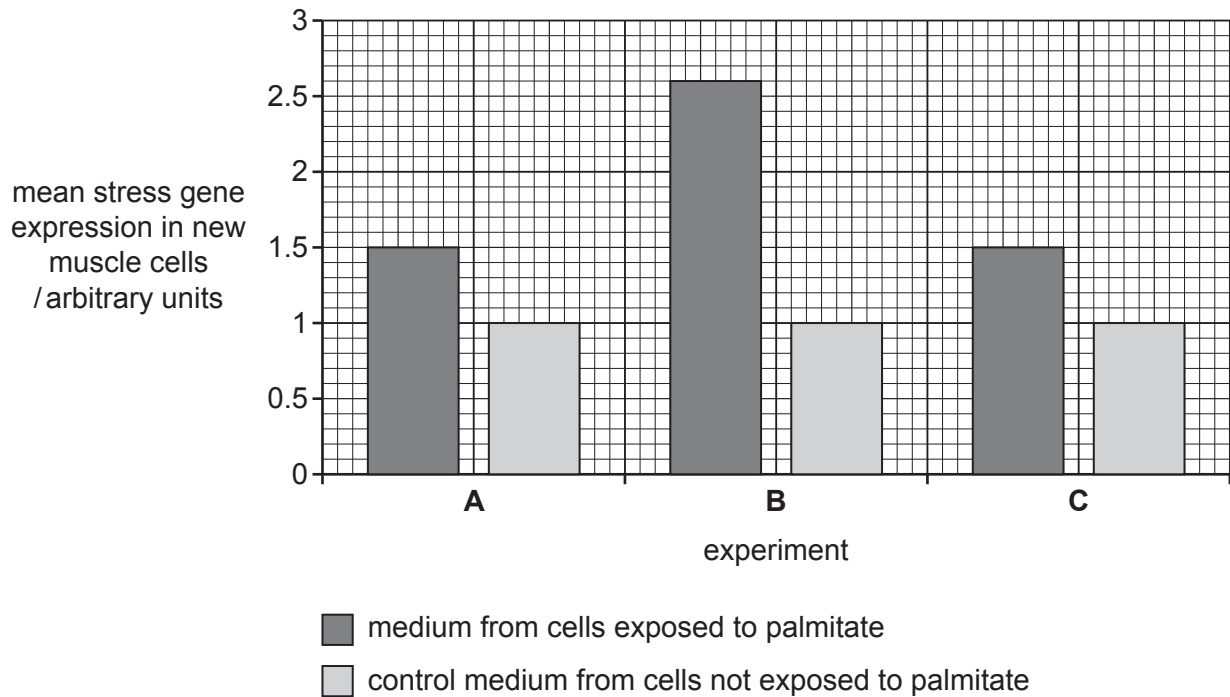


Fig. 2.1

With reference to Fig. 2.1, outline the conclusions that can be drawn about the cell signalling molecule involved in human muscle cell paracrine signalling in response to palmitate.

.....

.....

.....

.....

..... [3]

- (c) The process of protein translation is inhibited in developing muscle cells when stress genes are expressed.

LINKS WITH TOPIC 16

Suggest how developing muscle cells that express stress genes will differ in structure from normal muscle cells.

.....

.....

.....

.....

..... [3]

[Total: 10]

- 10** Humans detect the sweet taste of sucrose sugar using chemoreceptor cells in taste buds on the tongue. The red admiral butterfly, *Vanessa atalanta*, detects sucrose using chemoreceptor cells located on its antennae and on its tarsi (feet). The mode of action of the chemoreceptors in *V. atalanta* is similar to that in humans.

Fig. 10.1 shows the locations of the chemoreceptor cells on *V. atalanta*.



Fig. 10.1

Describe how the presence of sucrose causes an action potential in the sensory neurone associated with a chemoreceptor cell in *V. atalanta*.

..... [6

[Total: 6]

Biology 9700-Paper 4 Year 2024 (M/J) Variant 2

- 8 (a) Fig. 8.1 is a diagram of a sensory neurone.

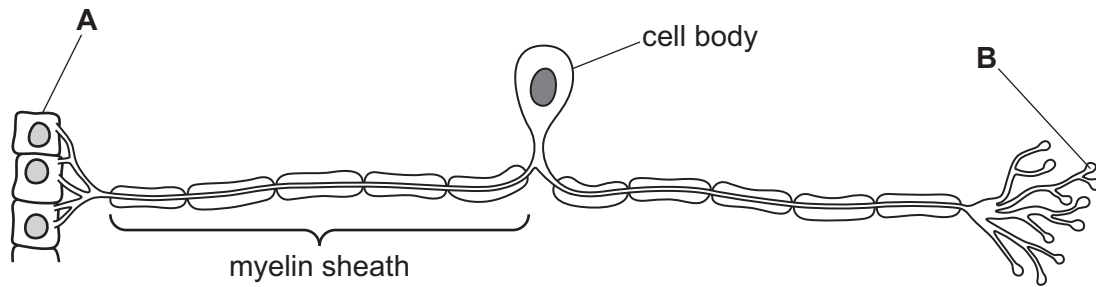


Fig. 8.1

- (i) Name the type of cell represented by cell **A**.
..... [1]
- (ii) Name a type of cell that forms a synapse with structure **B**.
..... [1]
- (iii) Name the cells that form the myelin sheath.
..... [1]
- (b) State **and** explain the differences in the transmission of impulses between myelinated and unmyelinated neurones.
.....
.....
.....
.....
.....
.....
.....
.....
..... [4]

- (c) Opioids are therapeutic drugs that are used to relieve pain. Morphine is an example of an opioid. It affects the functioning of synapses.

Fig. 8.2 is a diagram of a cholinergic synapse.

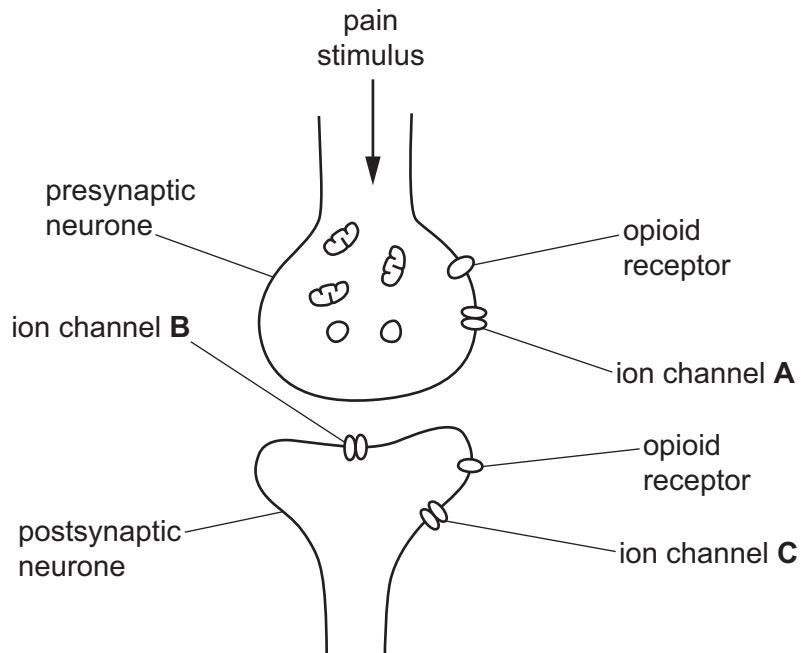


Fig. 8.2

- (i) With reference to Fig. 8.2, describe the differences between ion channel **A** and ion channel **B**.

.....

.....

.....

.....

..... [2]

- (ii) Morphine binds to the opioid receptor in the presynaptic membrane. This stops the ion channel **A** from opening.

Suggest **and** describe the effects of the binding of morphine to this opioid receptor on the functioning of the cholinergic synapse.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- (iii) Morphine also binds to the opioid receptor in the postsynaptic membrane. This results in the opening of ion channel **C**, allowing potassium ions to diffuse out of the cell.

Suggest how this would affect the synapse.

.....

.....

.....

.....

..... [2]

[Total: 15]

The diagram illustrates a cell with a microvillus. The cell surface membrane is shown as a wavy line. The axoplasm is the internal fluid of the cell. The microvillus is a finger-like projection of the cell surface membrane. The diagram is labeled with 'tissue fluid' above the cell, 'cell surface membrane' on the right, and 'axoplasm' below the cell. Arrows indicate the direction of movement of particles from the tissue fluid into the cell through the microvillus.

[2]

..... [4]

- (c) Table 10.1 shows the axon diameter, myelination and transmission speed of impulses of motor neurones for three animals: squid, cockroach and cat.

Table 10.1

animal	axon diameter /mm	myelination	transmission speed /ms ⁻¹
squid	1.5	no	30
cockroach	0.05	no	10
cat	0.02	yes	100

Describe **and** suggest explanations for the results shown in Table 10.1.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 10]

Biology 9700-Paper 4 Year 2024 (O/N) Variant 41

1 Different species of animal have neurones with different characteristics.

(a) Fig. 1.1 is a diagram of a motor neurone of a rat and a motor neurone of a snail.

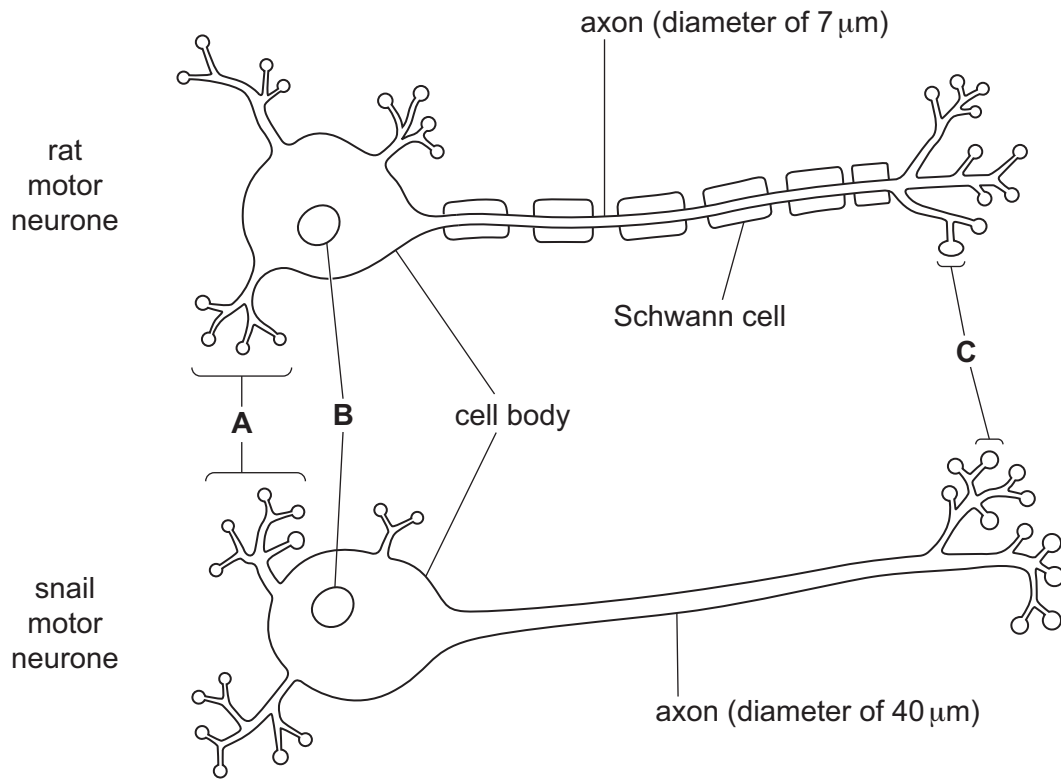


Fig. 1.1

(i) Name the structures labelled **A**, **B** and **C** on Fig. 1.1.

A

B

C [3]

(ii) The rat motor neurone has an impulse transmission speed of 50 ms^{-1} . The snail motor neurone has an impulse transmission speed of 8 ms^{-1} .

Explain why the rat motor neurone has a faster impulse transmission speed than the snail motor neurone.

..... [2]

- (b) Fig. 1.2 shows an action potential in a rat neurone and Fig. 1.3 shows an action potential in a snail neurone.

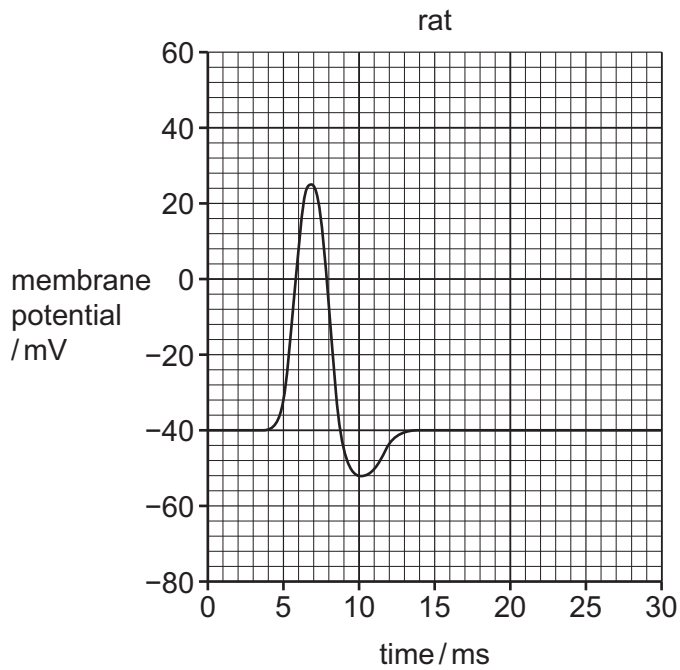


Fig. 1.2

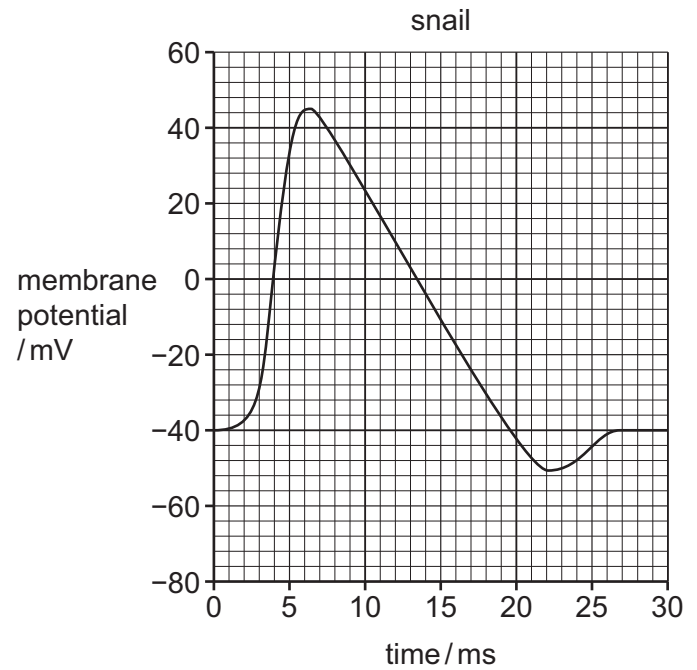


Fig. 1.3

Contrast the two action potentials shown in Fig. 1.2 and Fig. 1.3.

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 8]

- 4 The leaves of *Mimosa pudica* plants are made of a number of structures known as pinnae. The pinnae fold when the leaf is touched. This closes the leaf.

Fig. 4.1 shows an open leaf of *M. pudica* before it is touched. Fig. 4.2 shows the same leaf that has closed after being touched.

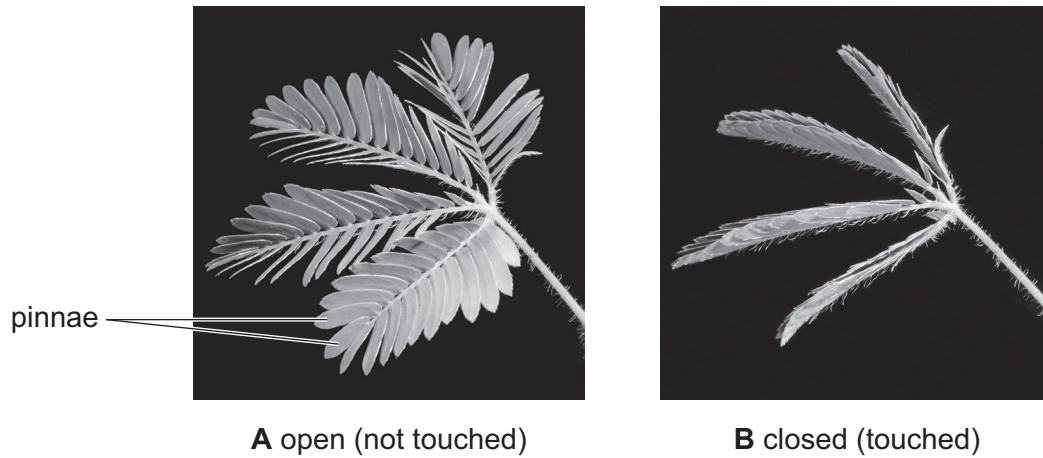


Fig. 4.1

Fig. 4.2

- (a) A touch stimulus to an *M. pudica* leaf causes an action potential to be generated.

The action potential results in changes in cells, which cause the leaf to close.

Fig. 4.3 shows the mechanism in *M. pudica* cells that causes the leaf to close.

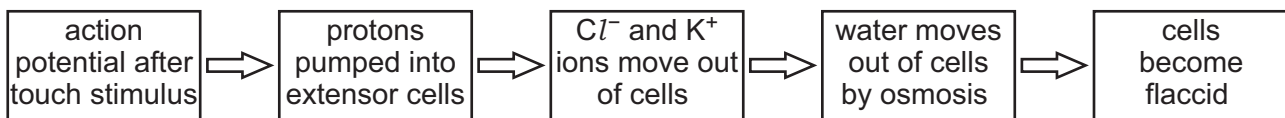


Fig. 4.3

The leaves of *M. pudica* and the leaves of Venus fly traps move in response to touch stimuli, but the mechanisms that cause the responses are different.

Describe the differences between the mechanism shown in Fig. 4.3 and the mechanism that causes the closure of the modified leaves in Venus fly traps.

.....

.....

.....

.....

.....

..... [3]

Biology 9700-Paper 4 Year 2024 (O/N) Variant 42

8 (a) Fig. 8.1 is a diagram of a motor neurone.

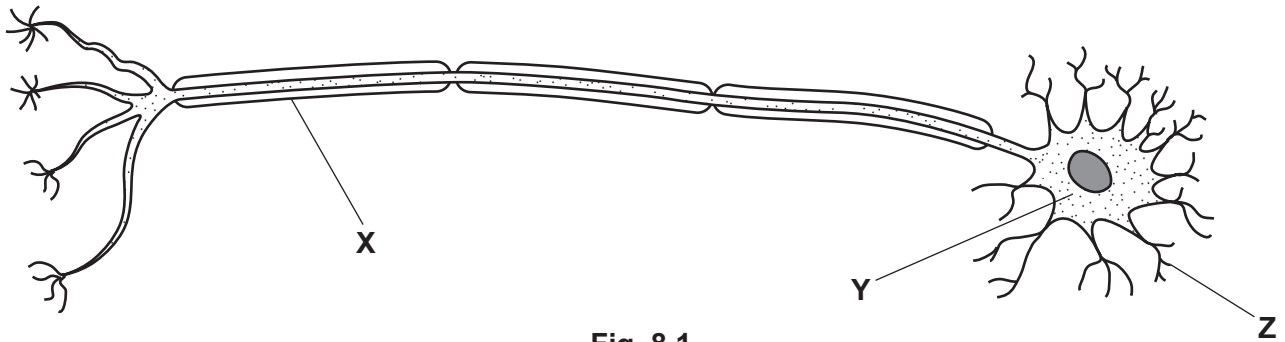


Fig. 8.1

(i) Name cell **X** and part **Y**.

X

Y

[2]

(ii) Name a type of cell that forms a synapse with structure **Z**.

..... [1]

(b) Table 8.1 shows some of the events that occur during muscle contraction.

They are **not** listed in the correct order.

Table 8.1

event	description of event
A	calcium ions diffuse out of sarcoplasmic reticulum
B	myosin heads bind to actin
C	sarcolemma depolarised
D	sarcomere shortens
E	calcium ions bind to troponin
F	T-tubule system membranes depolarised
G	binding sites on actin exposed
H	myosin heads tilt
I	tropomyosin moves
J	troponin changes shape

Complete Table 8.2 to show the correct order of the events that occur during muscle contraction. Two of the events have been completed for you.

Table 8.2

correct order	letter of event
1	
2	
3	
4	
5	J
6	
7	
8	
9	
10	D

[4]

- (c)** Lambert-Eaton myasthenic syndrome (LEMS) is a rare disorder of the neuromuscular junction. A person with LEMS produces antibodies that bind to the voltage-gated calcium channels on the presynaptic knob. One symptom of LEMS is weaker muscle contraction.

Suggest **and** explain why LEMS leads to weaker muscle contraction.

[4]

[Total: 11]

Biology 9700-Paper 4 Year 2025 (MARCH)

- 10 (a) Fig. 10.1 shows chemoreceptor cells in a taste bud. Two of the chemoreceptor cells have formed synapses with sensory neurone dendrites.

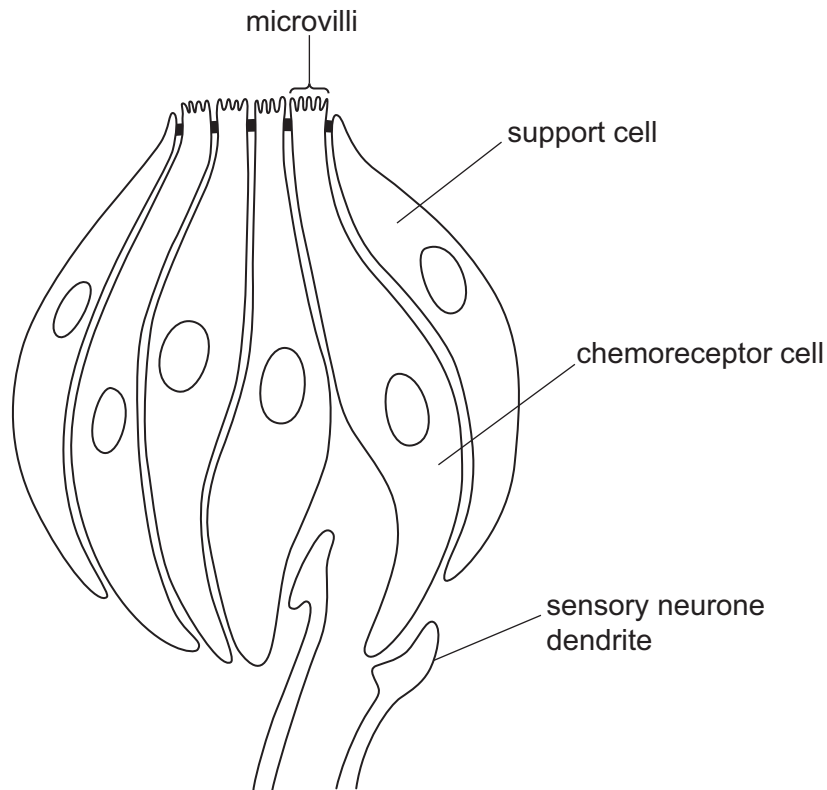


Fig. 10.1

Describe how the contact of sodium ions with the microvilli of the chemoreceptor cell can lead to the release of a neurotransmitter by the cell.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

- Table 10.1 shows the potential difference across the neurone membrane at three sequential time points, **X**, **Y** and **Z**, just before and during an action potential.

time point	potential difference /mV
X	-70
Y	+40
Z	-90

- [7]

- (b) Suggest how one action potential causes an action potential in an adjacent section of the axon of an unmyelinated neurone.

.....

.....

.....

..... [2]

- (c) Vertebrate animals generally have a myelin sheath around the axons of motor neurones.

Explain why the presence of a myelin sheath around a motor neurone axon is an advantage.

.....

.....

.....

.....

.....

.....

.....

..... [3]

[Total: 12]

- Describe **and** explain how a resting potential of an axon membrane is maintained.

[6]

- (b) Hypokalaemia is a condition in which there is a low concentration of potassium ions (K^+) in the body. This can affect nervous coordination.

Fig. 7.1 shows a normal action potential and Fig. 7.2 shows an action potential of a person with hypokalaemia.

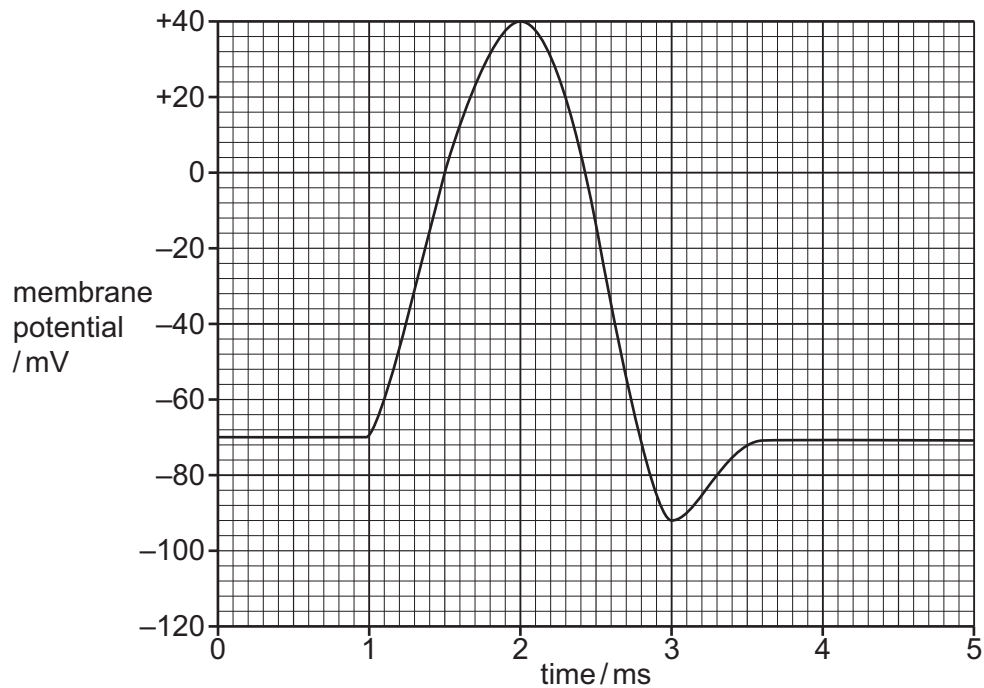


Fig. 7.1

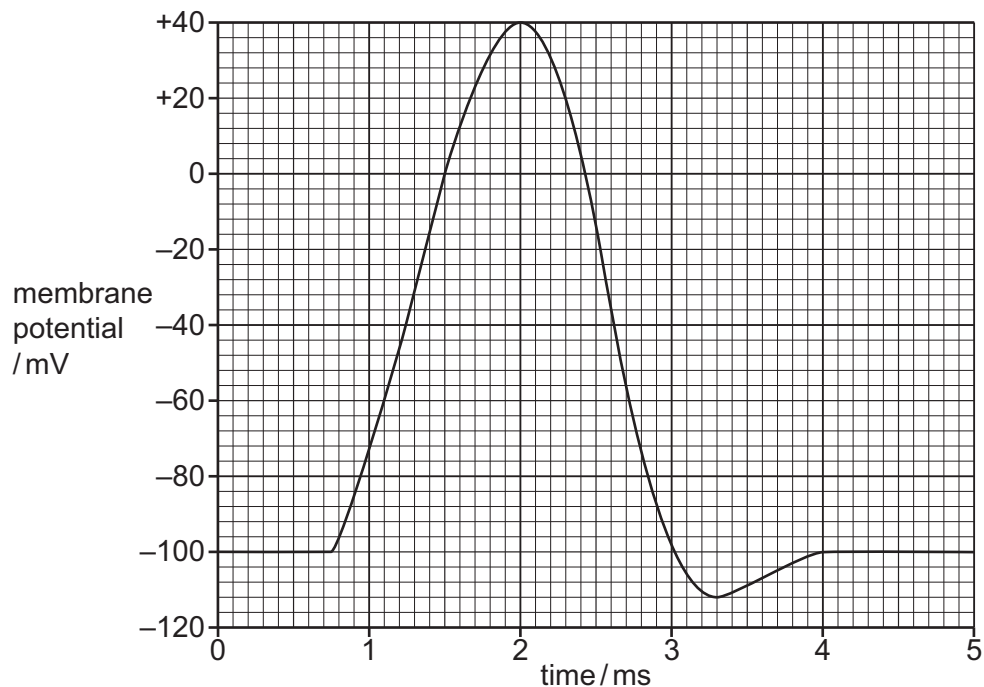


Fig. 7.2

- (i) With reference to Fig. 7.1 and Fig. 7.2, describe the differences between a normal action potential and an action potential of a person with hypokalaemia.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (ii) Suggest how hypokalaemia may affect nervous coordination.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 11]

Outline why a carnivorous mammal makes more use of its nervous system, rather than its endocrine system, when it hunts.

[4]

A line drawing of a neuron. It features a central cell body (soma) with a circular nucleus. Several dendrites extend from the cell body, branching out to receive signals. A long axon extends from the cell body, covered by a myelin sheath, and terminates in a branching structure.

On Fig. 9.1, add label lines and the letters **R**, **S** and **T** to label a part of the neurone that:

- can become depolarised – use the letter **R**
- contains many mitochondria – use the letter **S**
- acts as an insulator – use the letter **T**.

Classified by Mr. Adeel Ahmad

(c) Fig. 9.2 summarises changes that occur during the contraction of a sarcomere.

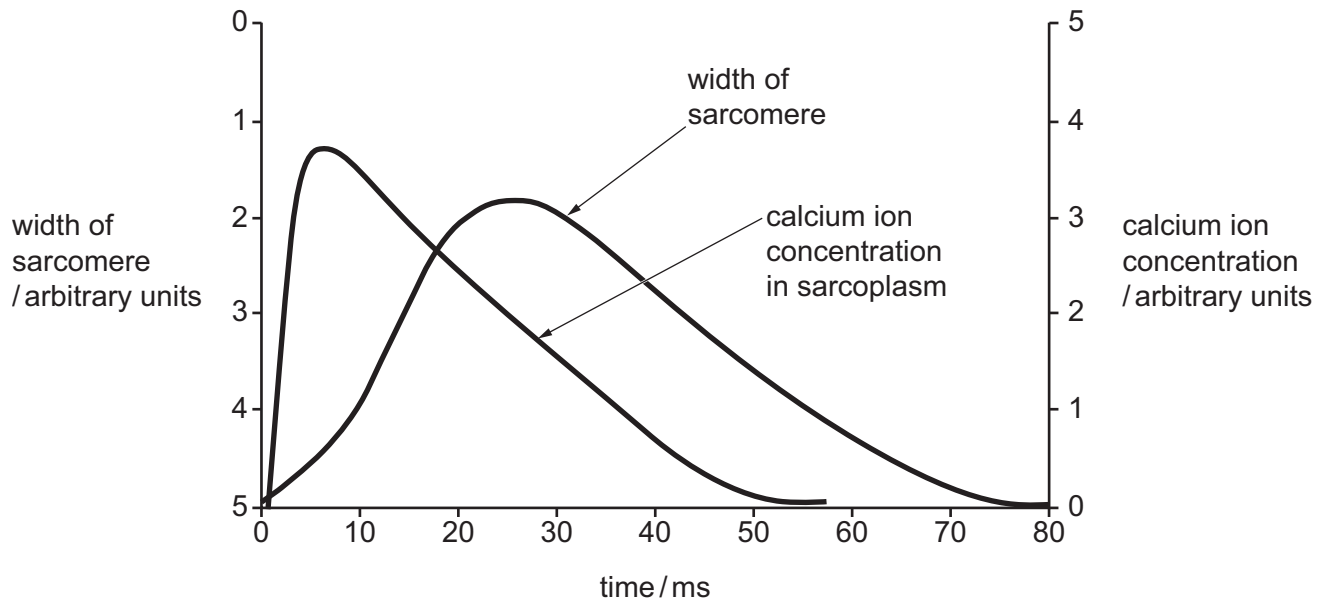


Fig. 9.2

- (i) Suggest an explanation for the shape of the curve that shows changes in the width of the sarcomere.

.....

.....

.....

.....

.....

..... [3]

- (ii) Suggest an explanation for the curve that shows changes in calcium ion concentration.

.....

.....

.....

.....

.....

..... [3]

[Total: 13]

Biology 9700-Paper 4 Year 2025 (M/J) Variant 44

- 8 (a) Fig. 8.1 is a transmission electron micrograph of striated muscle.

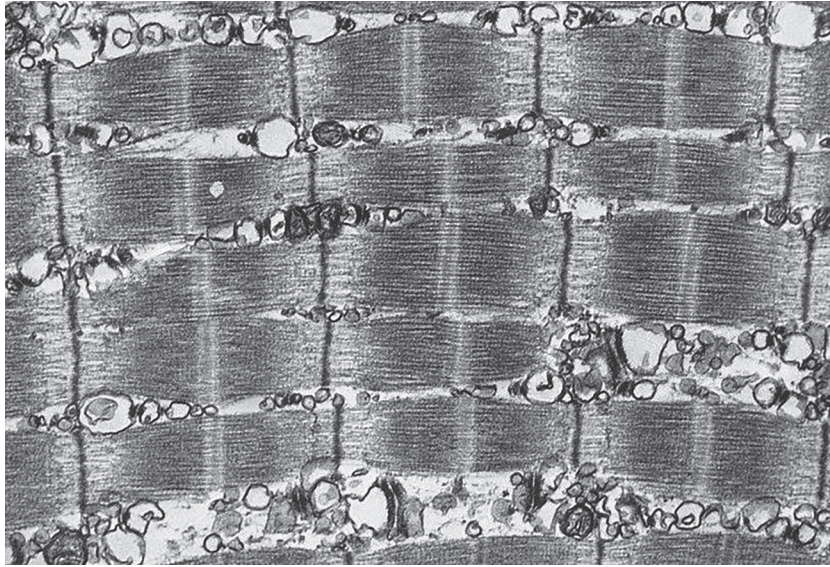


Fig. 8.1

On Fig. 8.1:

- use the letter **P** with a label line to show a region containing only actin
- use the letter **Q** with a label line to show a region containing only myosin
- use the letter **R** with a label line to show a region containing both actin and myosin.

[3]

- (b) Striated muscle contraction is explained by the sliding filament model.

Outline the role of the proteins troponin and tropomyosin in the sliding filament model.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[4]

- (c) Striated muscles can sometimes become less efficient at contracting if they have been active for a long time. This is called muscle fatigue.

Suggest why muscles may become fatigued.

.....

.....

.....

.....

.....

.....

..... [2]

[Total: 9]

SECTION B

Section B is being removed from paper 4 since 2022, but it is still a very good resource to practise conceptual parts of the curriculum. Use these questions sensibly and make them a part of your revision notes.

Classified by Mr. Adeel Ahmad

9700/41/O/N/14

- 9 (b) Describe and explain how gibberellins are involved in the germination of wheat or barley seeds. [7]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 10 (a)** Describe the response of the Venus fly trap to touch. [8]
- (b)** Explain the control of gibberellin synthesis **and** outline how gibberellin stimulates stem elongation. [7]

[Total: 15]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 10 (a)** Describe the structure of a motor neurone. [6]
- (b)** Describe **and** explain the transmission of an action potential in a myelinated neurone. [9]

[Total: 15]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- 10 (a)** Compare the endocrine and nervous systems in control and co-ordination in mammals. [8]
- (b)** Outline the role of a chemoreceptor cell in the human taste bud in detecting stimuli **and** in stimulating the transmission of nerve impulses in sensory neurones. [7]

[Total: 15]

[illegible]

- 10 (a)** Describe how a spinal reflex arc functions **and** explain why it is an advantage to a mammal. [9]
- (b)** Explain the importance of the myelin sheath in determining the speed of nerve impulses. [6]

[Total: 15]

[illegible]

9 (a) Describe the sliding filament model of muscular contraction.

[7]

[illegible]

10 (a) Explain how a cholinergic synapse functions.

[7]

[illegible]

- 10 (a)** Describe the roles of the neuromuscular junction, transverse system tubules (T-tubules) and the sarcoplasmic reticulum in stimulating contraction in striated muscle. [7]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

10 (a) Describe the ultrastructure of a striated muscle fibre. [8]

(b) Explain how auxin causes plant cells to elongate. [7]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 10 (a)** Describe **and** explain how the stimulation of sensory hair cells of a Venus fly trap plant leads to an insect being trapped. [8]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

10 (b) Compare the endocrine and nervous systems in control and co-ordination in mammals. [8]

[Total: 15]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

10 (a) Describe **and** explain the transmission of an action potential in a myelinated neurone. [9]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

- 10 (b) Explain the control of gibberellin synthesis **and** outline how gibberellin stimulates stem elongation. [8]

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....